PETROLEUM PROCESSING

including Petrochemical Processing Section

M A Y 1 9 5 4

Diesel Future Bright

Forecast for 1960 — 35% increase in demand — up to 9 billion gallons total — p. 681

Vessel Linings

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New Treating Process

Two-layer technique for removing mercaptans from gasoline — p. 691

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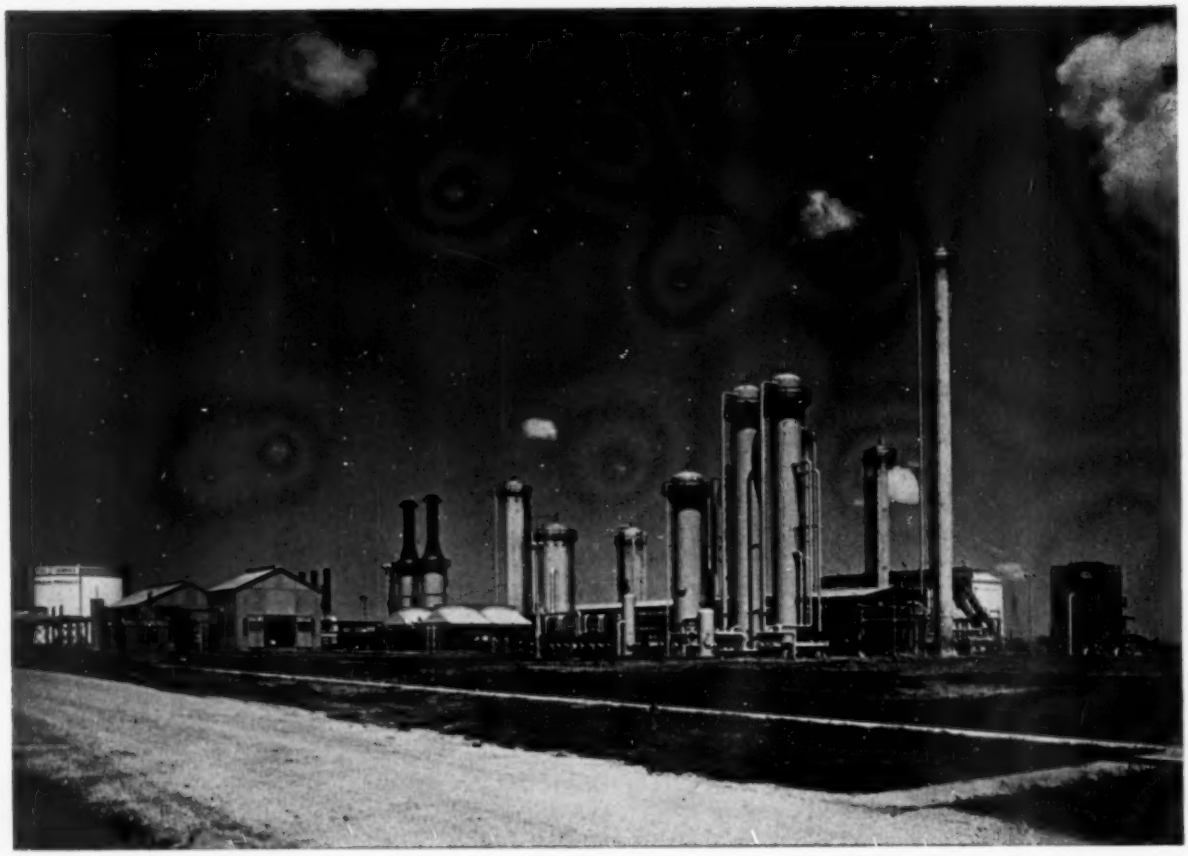
A McGRAW-HILL PUBLICATION



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The secret of flying a B-36

The Strategic Air Command tells us the average age of the First Pilot on a B-36 is 32 years. (This would have made him an old man among World War II fliers.) He ranks captain, major, or better. And he has an average of 3,800 hours' air time to his credit in multi-engine aircraft. The "secret" of flying a B-36 is the good judgment that comes only from experience.

In this respect, we think it's interesting to note the similarity of flying such an aircraft to working on the intricate problems of relating fuels to engines. Here, too, there is simply no substitute for years of intensive and specialized experience.

(Continued on next page)

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

Printed in U. S. A.

The secret of flying a B-36

(Continued from preceding page)

That's why we think you will be interested to know that the key men in charge of engine-fuel studies at Ethyl have an average of 19 years' experience in their individual specialties. When they engage in any cooperative work or consultation with you, they draw on a rich background of thousands of hours of laboratory work and millions of miles of road tests. And, as an organization, Ethyl Research Laboratories have worked closely with the petroleum and automotive industries for 31 years.

These years of experience give Ethyl a special insight into the complex problems of relating engines, fuels and lubricants . . . an insight we believe adds considerably to the value of "Ethyl" antiknock service.

ETHYL CORPORATION

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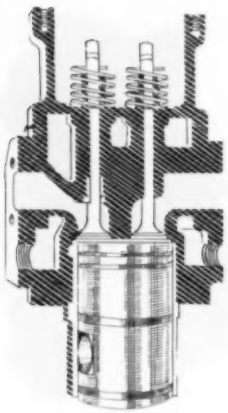
WORTH NOTING



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PETROLEUM PROCESSING

Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels lubricants and cor-o-ucts.

May, 1954
Vol. 9, No. 5

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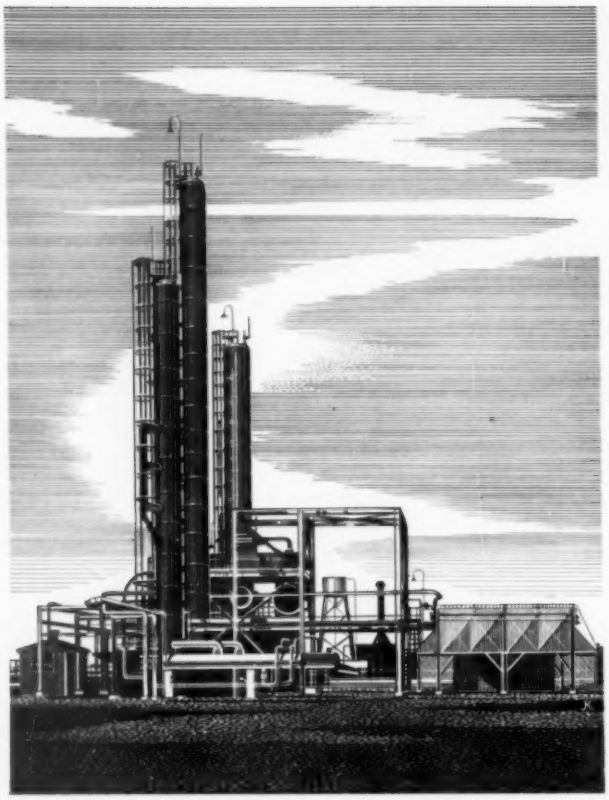
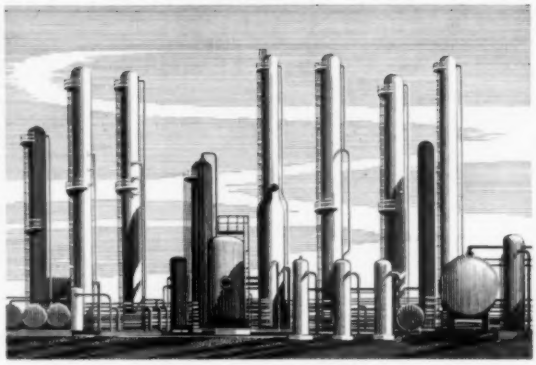
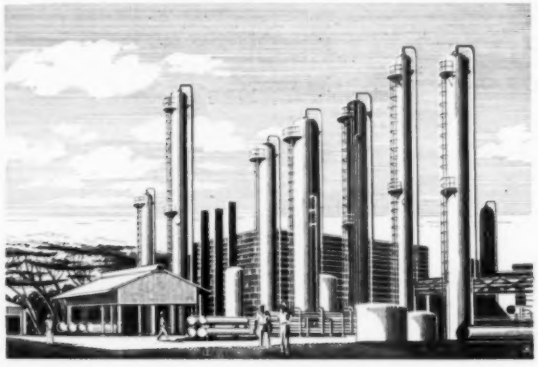


Located near Ballinger, Texas, the above plant (designed, engineered and constructed by Fluor for Runnels Gas Products Corp.) recovers 85,000 gallons daily of LPG and gasoline.



Built by Fluor, this natural gasoline plant for Warren Petroleum near Lovington, New Mexico, processes 22 mmcf/d.



Fluor designed, engineered and constructed this natural gas absorption plant, crude stabilizer and crude topping plant, Colombia, South America, for Colombian Petroleum.

Three more natural gasoline plants by FLUOR

BRINGING THE TOTAL TO 28

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PETROLEUM PROCESSING

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See You at the Refining Meeting in Houston

YOU'VE probably had the same experience many times, but we're continually amazed at the way in which little ideas will develop and grow into something big.

You'll find an example of just that in this issue. I'm referring to the special section starting on pg. 704 and devoted to the API Division of Refining and its Mid-Year meeting.

Actually, that section represents two ideas.

The first was one we had back in 1949. We'd been thinking for some time about the importance of the work of the Refining Division, and trying to figure out a way in which to bring it more to the attention of the industry. We finally hit on the idea of reporting each year on the work of the various technical committees, and in our April 1950 issue we published the first of what has become an annual review of what the committees have done and are doing, written for us by the committee chairmen.

That's an idea which has grown from four pages in 1950 to 25 pages in this issue.

The other idea was one which a group of oil people had some 26 years ago. At that time the API was one big family, but some of its members, mindful of the growing complexity of the industry, had the idea that it could be of more service if it were organized on a divisional basis. Accordingly, at the annual meeting in Nov. 1928 the API Board of Directors approved in principle the idea of organizing three divisions —including one on Refining. One of the aims of this action was "to provide a forum for the discussion of problems particularly pertinent to a specialized branch of the industry."

Subsequently, the Division of Refining was organized in 1930, and held its first meeting in January of that year. At that time, the General Committee on Refining was made up of 15 members—today it has 60; there were about 325 members enrolled in the Division—today there are 1900; there was one technical committee on Refining—today there are seven.

Mere growth in numbers, however, doesn't prove worth; quantity doesn't necessarily mean quality. But if you'll read the stories in our special API section, particularly the special projects features beginning on pg. 708 and the committee reports beginning on pg. 715, I'm sure you'll agree with us that the API Division of Refining is doing a particularly effective job.

William F. Bland

Editor

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National Petroleum News
The weekly oil marketing magazine, covering news, prices, transportation, storage, merchandising.

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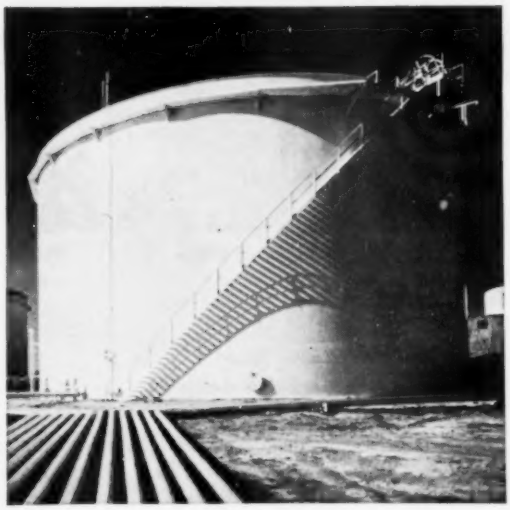

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What's Happening...

in Expansion

. . . Petroleum capital expenditure plans for 1954 include $1,277,640,000 for new processing plants and equipment in the U. S., according to studies recently completed by PETROLEUM PROCESSING and the McGraw-Hill Department of Economics. This amount represents a gain of 21% over actual 1953 expenditures of $1,056,250,000. A tabulation of actual 1953 and planned 1954 capital expenditures for all phases of the petroleum industry is given below:

	Actual 1953	Planned 1954	% Change
	(in thousands of dollars)		
Production	$2,197,000	$2,281,500	+ 3.9
Processing*	1,056,250	1,277,640	+21.0
Transportation	464,750	319,410	—31.3
Marketing	507,000	547,560	+ 8.0
Other	—	136,890	—
TOTAL	$4,225,000	$4,563,000	+ 8.0

* Processing includes refineries, natural gasoline and cycling plants, and petrochemical units.

. . . A similar study by API follows essentially the same pattern. Their figures, adjusted to include refineries, natural gasoline and cycling plants, and petrochemical units under processing, are as follows:

	Actual 1953	Planned 1954	% Change
	(in thousands of dollars)		
Production	$2,193,297	$2,206,192	+ 0.6
Processing	883,358	1,046,207	+18.4
Transportation	389,516	314,566	—19.2
Marketing	329,133	370,366	+12.5
Other	60,952	66,868	+ 9.8
TOTAL	$3,856,256	$4,014,199	+ 4.1

. . . Great Northern Oil Co. expects to let contracts this month for its new 20-25,000 b/d refinery at St. Paul, Minn. Projected plant (see What's Happening, Jan. '54, p. 7, and Feb. '54, p. 151) will include crude and coking units, Thermofor catalytic cracking, hydrodesulfurization and Ultraforming (licensed by Indiana Standard), UOP catalytic polymerization and auxiliary units.

. . . Richards Oil Co. of Minneapolis has acquired 132-acre site on Minnesota River at Savage, Minn., and is considering building a $500,000 to $750,000 refinery there. Refinery would run on Montana and Wyoming crude.

. . . Esso Standard Oil Co. will spend over $15,000,000 for modernization of its 58,000 b/d Baltimore, Md., refinery. Included in the project are a 10,000 b/d Fluid coking unit, 3,000 b/d Hydroformer, and three Hydrofining units. Later units will use by-product hydrogen from the Hydroformer, and will have capacities of 12,000 b/d of straight run naphtha, 5,000 b/d of heavy catalytic heating oil, and 3,000 b/d of heavy naphtha Hydroformer feed stock. Bechtel Corp. will construct coking unit, Foster Wheeler Corp. the Hydroforming and Hydrofining units. Also included in modernization is a new consolidated mechanical shop to replace existing scattered shop facilities, being built by Whiting-Turner.

. . . Imperial Oil Co. has let contract to Canadian Kellogg Co. for its new $14,000,000 lubricating oil plant at Edmonton, Alberta. The plant will include the first installation of a new Hydrofinishing process for finishing lube oils, which involves passing hydrogen through the lubricant to remove impurities and replaces clay filtration. Hydrogen for the process will come from a new 2,000 b/d catalytic reformer.

. . . Sun Oil Co. has let contracts to Catalytic Construction Co. for three major additions to its U. S. refineries. At Toledo, Ohio, a 27,000 b/d Houdriflow catalytic cracking unit will be installed as part of a 48,000 b/d combination crude unit. At Marcus Hook, Pa., a 27,000 b/d Houdriflow unit and 18,000 b/d Houdriformer will be installed. The new units are scheduled to be on stream early in '55.

. . . Esso Standard Oil Co. plans to install a 9,500 b/d catalytic polymerization unit at its Bayway, N. J., refinery, with completion expected next spring. Also planned are new gasoline blending facilities, which will replace present "batch" blending tanks and permit "continuous" blending of additives and dyes into gasoline as it moves through pipe lines on way to storage.

. . . Naph-Sol Refining Co. is planning installation of a 6,000 b/d catalytic reformer at its 5,500 b/d refinery at Muskegon, Mich.

. . . Union Oil Co. of California has fast tax write-off on $38,129,000 for a new refinery at Santa Maria, and expansion of its Oleum refinery. Facilities at Santa Maria will include basic refining and 18,700 b/d coking unit for preliminary processing of high-sulfur crude, which will be refined further at Oleum. For Oleum, $23,689,000 was authorized, to include reformer, polymerization unit, gasoline treater and sulfur removal unit, to produce an additional 7,720 b/d of high octane gasoline and 57 tons of sulfur.

in Petrochemicals

. . . Dow Chemical Co. is planning to construct a synthetic glycerin unit and polyethylene unit at its Velasco, Texas, plant, the combined cost of which will be $18 to $20 million. Glycerin unit will be second such synthesis unit to be built in this country, Shell Chemical having had one in operation at Houston for some years. Dow process will differ from Shell's, reportedly, although it

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

will still start with propylene and proceed via the allyl chloride route. Completion targets are Jan. '56 for glycerin unit, July-Aug. '55 for polyethylene.

. . . **Refiners with coke** and an urge to get into petrochemicals might want to look at the 52-acre calcium carbide plant at Ashtabula, Ohio, which General Services Administration is offering to sell to highest bidder. Plant cost $3,250,000 to build and equip in 1941, and can turn out 70,000 tons of calcium carbide annually. An article "Refinery Coke—New Source of Petrochemical Profits" in this issue (p. 733) points out how refiners might make acetylene from petroleum coke via calcium carbide route.

. . . **United Chemical Co.** (newly formed with eastern capital), plans an $18,000,000 plant near Timpson, Texas, to produce 320 tons of urea and 160 tons daily of ammonia. Natural gas requirements, 12,000 Mcfd, will come from nearby gas lines or shut-in fields. Foster Wheeler is design engineer for the Casale ammonia and Pechiney urea processes.

. . . **Hercules Powder Co.** has leased (with option to buy) the Louisiana, Mo., facilities operated until last June as synthetic fuels plant by Bureau of Mines. Hercules originally built the facilities as an ammonia plant for the government in 1941.

. . . **"Petrox" is an unidentified petrochemical** which The Texas Co. is now using in its premium-grade gasoline. Company identified additive only as "a very specific material made under controlled conditions" and said it is "wholly combustible" and manufactured only by Texaco in a new unit at its Port Arthur refinery. Advantages claimed for additive in gasoline are reduced engine wear, substantially improved economy, maximum power developed and sustained, improved valve performance and valve life, thorough rust protection, reduced octane requirement build-up, reduced induction system deposits, protection against stalling, greatly increased spark plug life.

. . . **Tanker hauling of petrochemicals** is planned by Standard of California. It is refitting its "R. G. Follis" to carry materials marketing through its subsidiary Oronite Chemical Co. from the Richmond and El Segundo plants to the East and Gulf coasts, bringing back Eastern blending stocks and chemical raw materials.

. . . **Supplementary instructions on bidding** for government-owned synthetic rubber plants have been issued by Rubber Production Facilities Disposal Commission. Copies of releases No. 3 and 4 may be obtained from commission at 811 Vermont Ave., N. W., Washington 25, D. C.

. . . **The Texas Co.,** planning further expansion in the petrochemical field, has placed William P. Gee, formerly assistant to President Augustus C. Long, in charge of petrochemical activities, including synthetic rubber.

in Markets and Prices

. . . **Gasoline trading was active** at the Gulf Coast during April, and prices recovered from their March lows. At the Gulf, probably 2,000,000 bbls. of spot gasoline was picked up for early cargo and barge shipment. Easing of the pressure on the Gulf cargo market left virtually no sellers of premium grade in distress, and "maybe only one or two" on regular.

. . . **Product markets generally were firmer** than in several recent years as the industry moved into the summer season, according to many refiners, as a result of the inroads on the gasoline surplus.

. . . **There were still several "weak spots,"** however, including a 0.5¢ decline in prices for Grade 26-70 natural gasoline in the Mid-Continent, bids ranging down to 8.48¢ per gal. to supply the government with JP-4 jet fuel, and special "protection" plans to stave off dealer failures in the New Jersey retail market.

. . . **Current low inventories of distillate and residual** fuel oils in seaboard areas were one reason refiners gave optimistic market reports. Along the East Coast, trade reports showed there has been no substantial carry-over this year of light fuel inventories. And imports of heavy fuel were tapering off seasonally, with the result that some terminal operators actually had to spread out supplies pending cargo arrivals from the Gulf or Caribbean.

. . . **No. 6 fuel was more plentiful in inland areas** than on the seaboard. In Chicago, Standard Oil Co. (Ind.) cut its heavy fuel tank wagon prices 0.5¢, April 1, its new price for Stanolex "C" down to 7.75¢.

. . . **Alkylate was the only specialty** attracting any spot market demand. Inventories of avgas, lubricating oils and waxes continued to increase, and lubricating oils, Tulsa basis, were quoted from 1¢ to 2¢ lower.

Transition

. . . **Gulf Oil Corp.** closed its 8,000 b/d refinery at Ft. Worth, Texas, on May 1 because it was incapable with existing equipment to meet current quality demands, and didn't lend itself to enlargement and modernization. The plant went into operation in 1912.

. . . **Clark Oil & Refining Corp.** is the new name of the former **Petco Corp.,** which operates a 20,000 b/d refinery at Blue Island, Ill., and is currently installing a 4,000 b/d Platforming unit there.

. . . **Chicago Corp.** is taking over immediate management of Champlin Refining Co., Enid, Okla., and its subsidiary, Peppers Refining Co., Oklahoma City, under agreement to purchase both firms for total of $55,000,000. Capacity of Enid plant is 22,000 b/d, while Peppers refinery is rated at 1,750 b/d.

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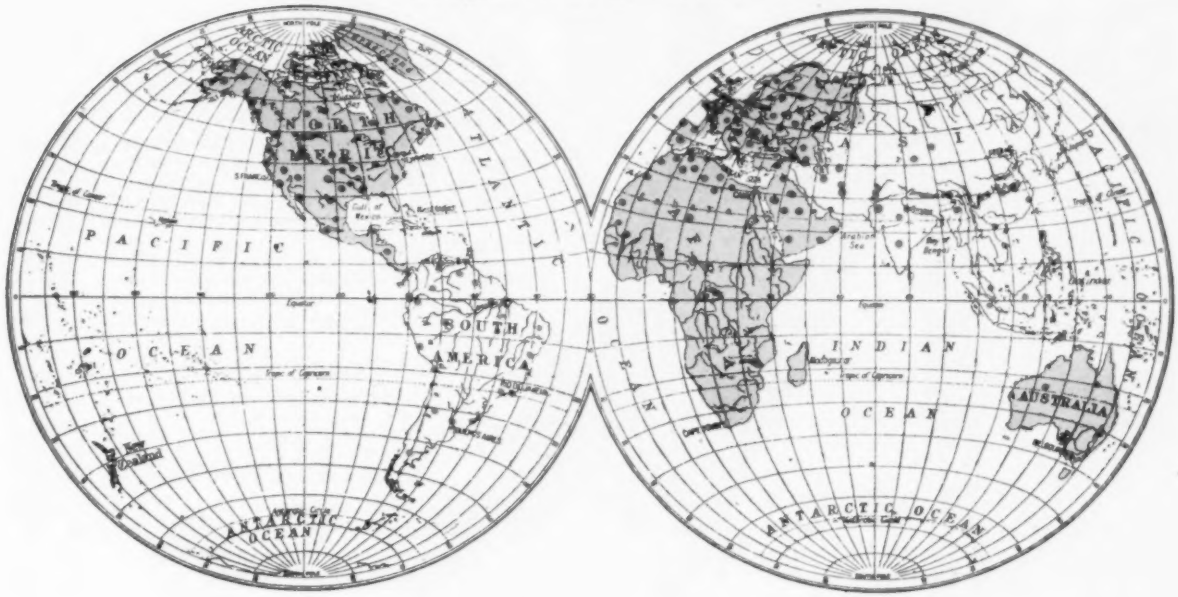

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HEAT EXCHANGER PLANT: Honesdale, Pa.

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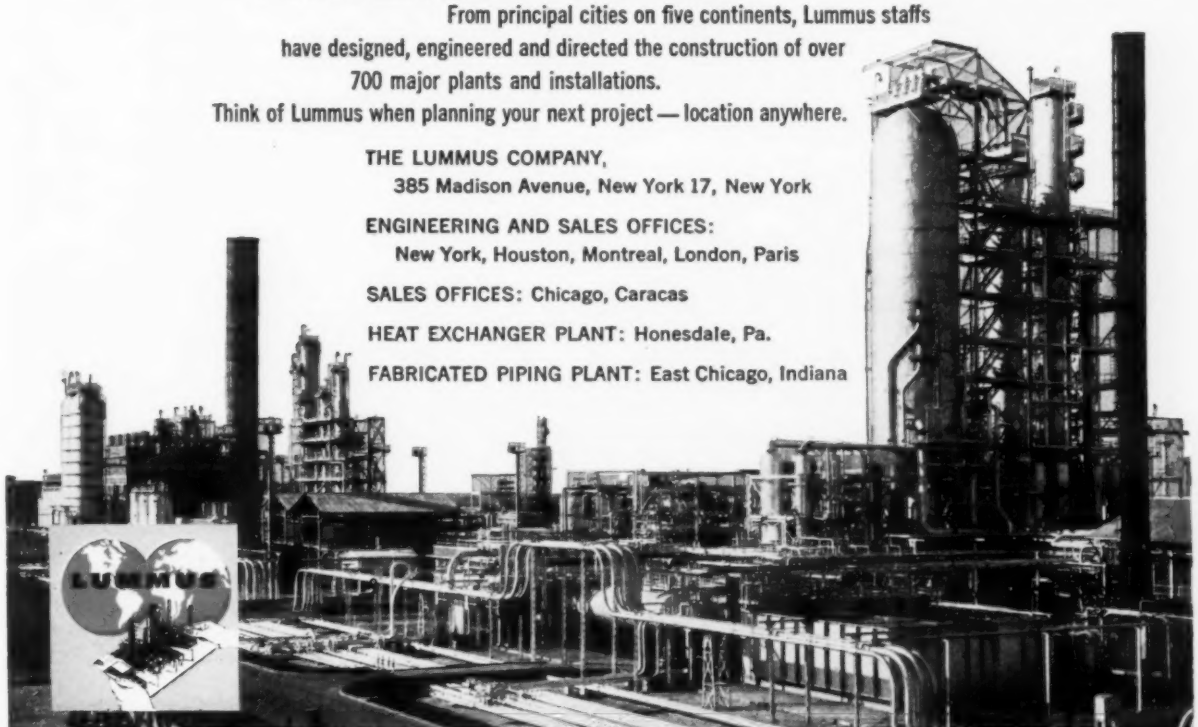

ILLUSTRATED: 40,000 B/D petroleum refinery at Dunkirk, France, designed, engineered and constructed by Lummus for the Societe Generale des Huiles de Petrol.

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That's a trick requiring plenty of specialized experience. However, this scene at the great Shell Refinery at Houston, Texas, indicates only one facet of the Graver Construction Company.

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Petrochemical Future Brightest for Those Who Expand their Research

THE future for the petrochemical industry is bright, but not for the timid or the fainthearted.

"Particularly, it is not for those who have let their research lapse during the post-war period when anyone could enter the petrochemical field and find a ready market for established products."

These words came from a well qualified authority in the field of organic chemicals, Harry B. McClure, president of Carbide & Carbon Chemicals Co.(1) For 20 years with this company, he has been concerned with new chemicals and finding new industrial uses for them.

"The more competitive conditions expected in 1954 might seem to confirm that a leveling off period in growth is overdue," he continues. "It is probable that plants with obsolete or high-cost processes will have a somewhat rough time. Those with courage and foresight, however, will look upon this period as an opportunity for expansion into new fields."

Mr. McClure's remarks on the future in petrochemicals apply equally to the oil companies extracting chemical materials from oil and gas, and the established chemical concerns. If his statements on the necessity for research in the years ahead were confined to technological work on new products and processes in the laboratory, the competitive outlook for the petroleum refiners might appear dim.

However, there is also economic and market research to consider, something within the province of many oil companies, even those at present not making petrochemicals. A principal distinguishing characteristic of petrochemical research, Mr. McClure brings out, is that it frequently starts "with the appreciation of the need for an end product and then looks for the raw materials to make it." In view of the numerous hydrocarbons in a barrel of crude available for manufacture of a variety of chemicals, such an approach to research seems appropriate for an oil company, and without going too far afield from the marketing territories natural to its refineries and gasoline plants. —V.B.G.

(1) "Research-Catalyst for Petrochemicals Growth" H. B. McClure, Carbide & Carbon Chemicals Co.; Chemical Industry Survey, *Investment Dealers Digest.*

Promise Is Seen in Pattern for Organizing Attack on Corrosion

MANY refiners now becoming more conscious of corrosion problems because of a recognition of their cost to the industry, may be surprised to learn that the natural gasoline industry has completed a 10-year program that has effectively remedied one of their serious problems in this field.

A 200-page report in book form, has been published on the subject by the Natural Gasoline Assn. of America.(1) It tells how a group of gas and gasoline companies organized the campaign, analyzed the particular corrosion problem, worked out its solution. Their findings as now presented are expected to result in common benefit of all operators.

The problem was highly complex—the corrosion of the valves, fittings and tubing in gas condensate wells with high gas-oil ratios and pressures in many instances well over 1500 psi. The condensation of water, along with the hydrocarbons, produced aqueous solutions of carbon dioxide and organic fatty acids. These were the agents of corrosion.

The cooperative work started in 1944, when it was recognized that internal corrosion in the high pressure wells was different from that in low pressure wells. An NGAA committee outlined a research program, some of which was carried on in oil company laboratories and some in outside institutions. A full time correlator of field studies was taken on. Funds to the amount of over $80,000 were contriubted by the interested oil companies over the 10 years.

An impressive amount of information was collected by the NGAA committee, which is presented in its report. Included are methods for detecting, measuring and locating corrosion in individual wells, for coupon evaluation of corrosion, and methods for its control by inhibitors, and the use of special steels, and so on. An economic evaulation places the uncontrolled cost of corrosion in gas condensate wells in 1951 at $12,-100,000, and the control cost at $2,100,000, indicating a potential saving of $10,000,000.

This specific form of corrosion encountered in gas condensate wells is not commonly a refiner's problem, CO_2 being eliminated before the crude reaches the refinery gate. However, some of the data on metallurgical factors should prove valuable, and the methods the natural gasoline plant operators set up to attack their problems are expected to be useful in the refiners' campaigns against their high corrosion costs. —V.B.G.

(1) "Condensate Well Corrosion", by the NGAA Condensate Well Corrosion Committee; published by the Natural Gasoline Assn. of America, Tulsa.

More Light Ends in Motor Fuel Seen as Stopper to 'Profit' Leaks

BETTER evaluation of such materials as butane along with a re-evaluation of their use for upgrading motor fuels is being regarded as a needed trend by at least one petroleum processor.

Refiners lost, through less economic usage, the equivalent of $100,000,000 in the summer of 1953 by failing to exploit existing knowledge of the permissible light ends contents in motor fuels, according to Phillips Petroluem Co.'s T. W. Legatski and H. J. Elder.(1) They estimate that an average of about 140,000 b/d of motor gasoline stock having a leaded octane number of 105 (extrapolated) was *not* disposed of as motor gasoline during this period.

Instead, it probably was burned under refinery

boilers. In turn, the fuel oil which was thus displaced presumably was used as heating oil last winter.

If diversion of such materials as butane, for example, into low-grade economic uses can be eliminated equivalent refinery processing will be saved and, at the same time, the refiner can make a very real technical contribution to fitting engines to fuels through reducing the spread in fuel characteristics for which cars must be designed.

The "lost profit" statement is based on surveys of gasoline sold in various areas which use the fact that Reid vapor pressure—when correlated with the slope of the ASTM distillation curve at some %-evaporated point in the forepart of the curve—will determine vapor pressure. Any discrepancy between this and the vapor pressure tolerance of cars as determined by road-testing represents the amount of butane, for example, which could have been used.

Since the motoring public is constantly conducting a motor gasoline survey of its own, customer acceptance of the product year after year is the published conclusion of this testing program. Marketed gasolines also represent the end result of a wide variety of raw materials and refining methods.

Sampling in these geographical areas and crossplotting vapor pressure and %-evaporated gives the spread of acceptable characteristics, prevailing practice, and more or less conservative practice. Superimposing the relationship of butane content on the existing data indicates whether or not more of this refinery surplus material could be used.

Examining the overall average composition of motor gasolines throughout the country, the authors reached the conclusion that an additional 4.2% of butane could have been blended on the average during the summer, without increasing incidence of vapor lock.

Further, based on a substantial amount of available information, still more butane probably could be used without encountering difficulty. This is calculated to be 6.3% instead of 4.2. The difference would amount to the order of 12,000,000 bbl. more, or around $50,000,000 "profit" from a cost-free motor fuel upgrading process.

At the same time, it is seen that still more butane would simplify the engine designers' problems, because there would be less spread in fuel characteristics. That is, the engines could be designed for a more specific fuel while the customer would never know the difference and, in fact, still would be getting his money's worth of high quality fuel. —D.P.T.

(1) "Octane Numbers to Burn," by T. W. Legatski and H. J. Elder, presented at Western Petroleum Refiners Ass'n. 42nd annual meeting, San Antonio, Texas, March 29, 1954.

Gasification of Natural Gasoline Seen As Way to Meet Peak Gas Demands

A NEW method of preparing artificial gas from natural gasoline has been developed by the Institute of Gas Technology in research sponsored by East Ohio Gas Co. Called "hydrogasification," the process is reported to yield a gaseous product completely substitutable for natural gas without the formation of coke, tars and aromatic by-products.

Here is the background for IGT-East Ohio's interest: Gas utilities need a better supplementary gas than can be produced with presently available methods to meet short-time peak loads which exceed normal natural gas supplies.

Most commercial processes for producing natural gas substitutes involve thermal cracking of distillates and natural gas liquids in regeneratively heated refractory lined vessels. Coke, light aromatics and tars are by-products to be disposed of, sometimes at a penalty because of the variable and unpredictable supply.

Product gases from these conventional processes often contain up to a third olefins and diolefins, an equal quantity of hydrogen, and the balance paraffin hydrocarbons. Unfortunately, this mixture has greatly different combustion characteristics compared to natural gas and is said to have created many problems in consumer-supplier relationships.

IGT's gasification process originally cracked 26-lb. natural gasoline at temperatures from 1380 to 1490° F., pressures from 51 to 67 psia., and residence time of 3.7 to 5 sec. The resulting gas, 76-79% yield, still contained considerable hydrogen and light olefins, but less than the product from conventional gasification.

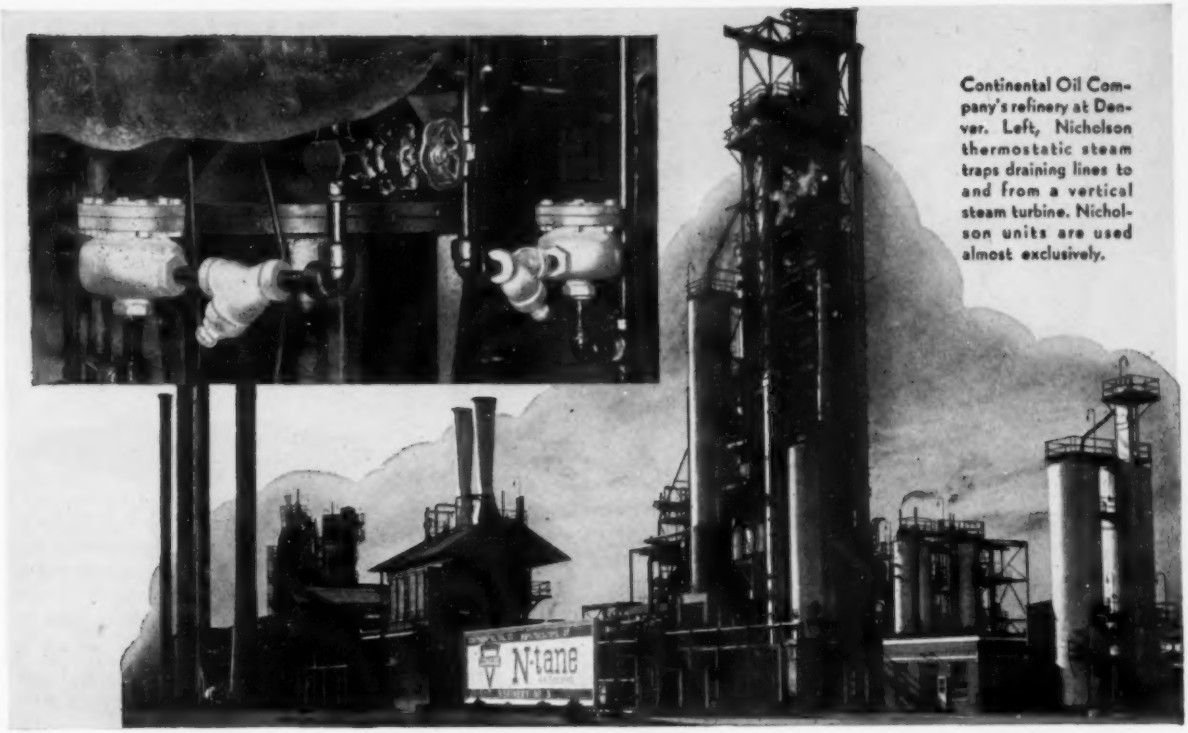
Further laboratory study indicated that the addition of limited quantities of hydrogen could be relied on not only to reduce the olefin content of product gases, but also the formation of liquid products. This was borne out in pilot plant testing under conditions of 70 psia. and feed rates of 60-70 Scf. of hydrogen per gal. of natural gasoline. Other conditions were for the most part substantially the same as the runs without feed hydrogen, except that temperatures were somewhat lower in order to minimize dehydrogenation reactions. Liquid production was nil and olefin concentration in the gas was substantially reduced.

The process has also been tried with a heavier, unleaded motor gasoline, and with kerosine. With the former, it was found possible to gasify 83 to 86 wt.-%, with 87 Scf. of hydrogen per gal.

Following further tests and economic evaluation with a variety of feeds it is expected that a commercial 1000 Mcf. per hour plant will be designed, presumably by East Ohio.

Commercial adoption of IGT's process would create a larger market for natural gasoline, and at the same time provide a more satisfactory supplementary gas for utilities when they face a peak demand.

On the other hand, the natural gasoline industry is itself plagued with a seasonal demand, and is in a worse position since its products are almost a drug on the market in late spring and summer when prices traditionally fall to seasonal lows. A solution to this problem could be found if gas utilities would accumulate their raw material supplies in summer—taking advantage of lower prices, unloaded transportation facilities, and the fact that natural gasoline lends itself to easier storage than does LPG. —D. P. T.



Continental Oil Company's refinery at Denver. Left, Nicholson thermostatic steam traps draining lines to and from a vertical steam turbine. Nicholson units are used almost exclusively.

NICHOLSON TRAPS SELECTED for CONOCO Refinery

This Continental Oil Company refinery has adopted Nicholson steam traps because they proved most effective generally in improving heat transfer. This is an advantage which, we believe, is important to plant men in every industry. A recent survey showed these Nicholson features to be the reasons why plants with standardization-for-economy programs are increasingly adopting Nicholson traps: (1) Two to six times average drainage capacity. (2) Operate at lower temperature differential. (3) No air binding. (4) Freeze-proof. (5) Only one moving part. (6) No change of valves for varying pressures. (7) Record low for steam waste. For process, power, heat.

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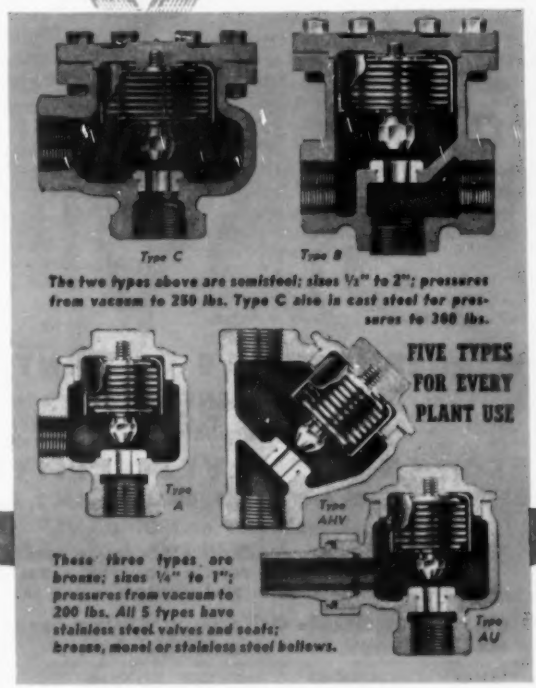
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Letters

It Doesn't Balance

TO THE EDITOR: The chemical equation on page 374 of the March issue of PETROLEUM PROCESSING ("How to Determine Arsenic Traces in Oil or Catalyst") is incorrectly balanced, apparently due to a typographical error on our part. The equation should have read:

$$6H^{+} + 3Zn + H_3AsO_3 \rightarrow AsH_3 + 3Zn^{++} + 3H_2O$$

instead of showing three molecules of H_3AsO_3. I regret that we did not notice this error before publication.

I wish also to thank you for the early publication of this article and for the fine manner in which it was handled. Your treatment of this material was very satisfactory.

RAYMOND R. JAY

Sinclair Research Laboratories, Inc.
400 East Sibley Boulevard
Harvey, Ill.

Thank you, reader—and author—Jay. Typographical error acknowledged. Also, error on part of our editor - in - charge-of-balancing-equations admitted.

A Smog Platform

TO THE EDITOR: . . . You might be interested to know that at the meeting of the Board of Directors of the (Western Oil and Gas) Association last month, they adopted the following petroleum industry policy statement, or "platform" on smog:

"The oil industry recognizes that as a member of the community it has a responsibility for the control of air pollution:

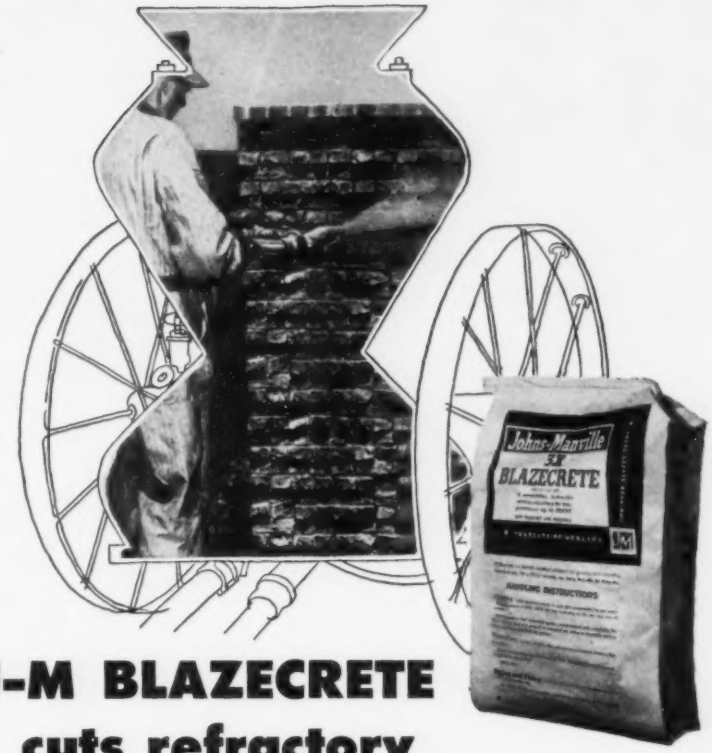
"(1) It is accepting that responsibility and will continue to do all that it can within the limits of technology to control pollutants originating within the industry.

"(2) In the belief that the final solution of this complex problem will come from greater knowledge, the industry will continue to sponsor research on air pollution in the community interest."

FELIX CHAPPELLET
Secretary and
Acting Manager

Western Oil and Gas Ass'n.
510 West Sixth Street,
Los Angeles 14, Calif.

Good news from the man who fought back when smog critics again tried to make oil their whipping boy.



J-M BLAZECRETE cuts refractory maintenance costs . . .

That's why it pays you to use this hydraulic-setting refractory for temperatures to 3000F

Blazecrete* materially reduces labor costs for refractory maintenance. This hydraulic-setting refractory saves time in building and repairing linings for high-temperature equipment.

For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place. When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete goes on fast, without laborious ramming or tamping. And Blazecrete linings *last.*

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix—can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

STANDARD BLAZECRETE—For temperatures through 2400F. Makes repair work easier and less costly. Can be used by boiler manufacturers to replace fire clay tile in wall construction. Suitable for use in combination with 3X Blazecrete and L. W. Blazecrete.

L. W. BLAZECRETE—For temperatures through 2000F. An insulating refractory . . . light in weight, low in thermal conductivity. Adaptable and economical for many other applications.

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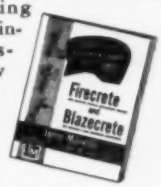

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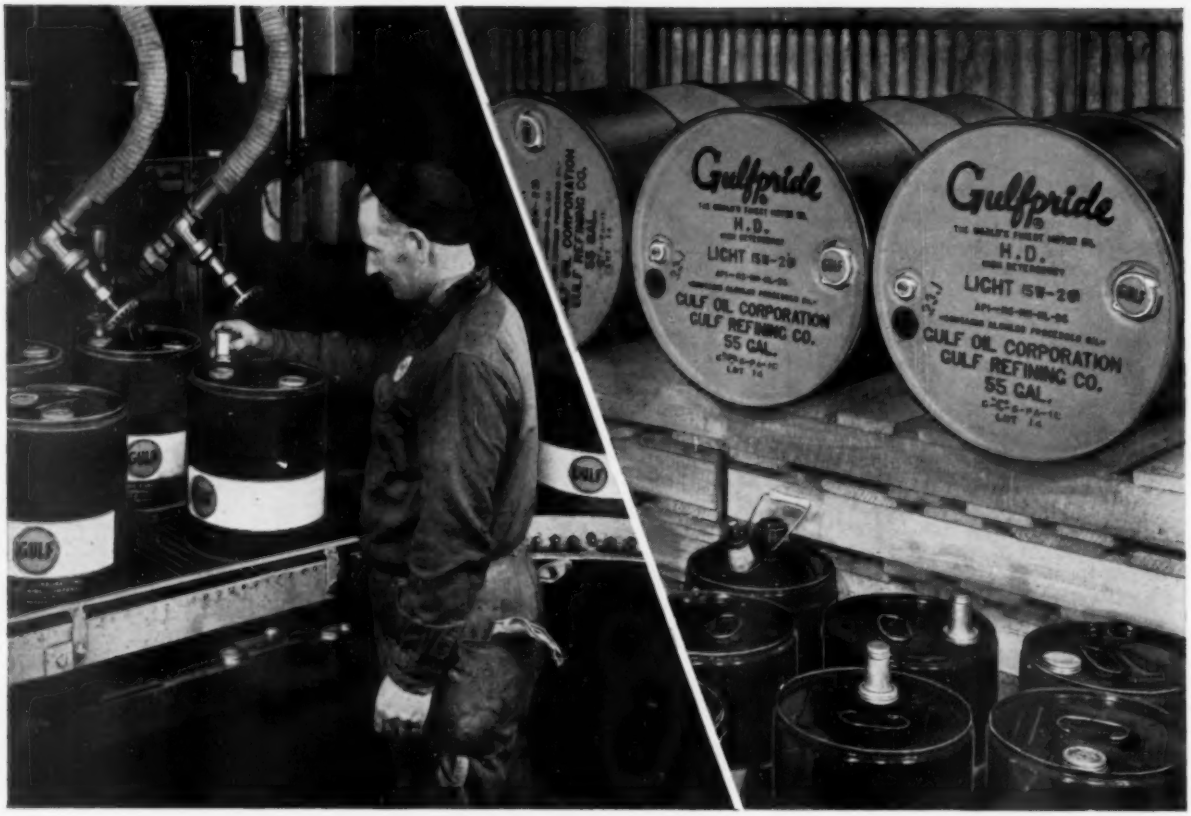

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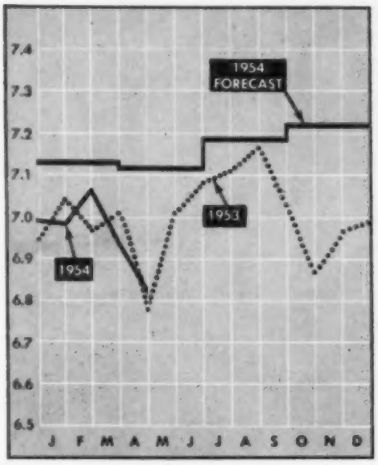
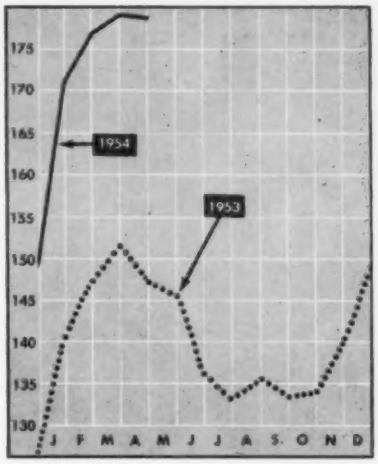
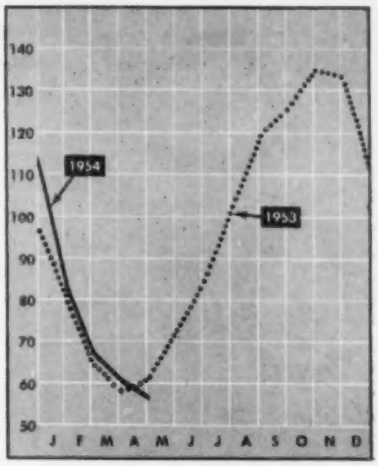


CRUDE RUNS TO STILLS
(Millions of b/d, monthly averages)



PRIMARY GASOLINE STOCKS
(Millions of bbls., end of month)



PRIMARY DISTILLATE STOCKS
(Millions of bbls., end of month)

Heavy Gasoline Stocks Depress Runs

OUTLOOK: Second quarter crude runs will average around 7,000,000 b/d avg.—Gasoline yields to continue 44-45%—Estimated required cushion of middle distillate stocks by Oct. 1 is 170-175,000,000 bbls.

Crude: Restricted refinery runs have increased crude oil stocks, leading Texas Railroad Commission to cut state's May allowable by nearly 200,000 b/d. Runs for U.S. slightly lower than year ago. April runs forecast at 6,960,000 b/d avg.

Gasoline: Despite oil company statements to Texas Commission, U.S. gasoline inventories are topheavy. April 10, at 179,729,000 bbls. (ex jet fuels) they were nearly 20,000,000 bbls. higher than April 11, 1953. To pare down to the 140,829,000 bbls. of Oct. 3, 1953, would require average withdrawals of 1,500,000 bbls. weekly for the coming 25 weeks, which will be difficult with the present rate of production due to high yields. Low of U.S. inventories this fall will likely be around 145-150,000,000 bbls.

"Ex" Jet Fuels

Data on gasoline, distillates and kerosine in "Trends," is exclusive of jet fuel components, in line with new method of reporting adopted by Bureau of Mines and API.

Heating Oils: Inventories of middle distillates (distillate and kerosine) in the U.S. April 10 (75,041,000 bbls.) were 4,337,000 bbls. less than a year ago. Current refinery output is at a slightly lower rate. Estimated requirements by Oct. 1 are 170-175,000,000 bbls. Oct. 3, 1953, inventories were 163,460,000 bbls. If crude runs continue to be held down, increased distillate yields may be an important factor in reaching the desired stock level.

Residuals: Both supply and demand of heavy fuels continue a long range downward trend. Supply (refinery output and imports) for three months, is 3.4% less than in 1953, while demand is 5.4% smaller. East of California, stocks in early April were some 2 million bbls. less than a year ago.

KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month).

	Apr. 1954	Mar. 1954	Apr. 1953
CRUDE OIL			
U.S. Production	6.562	6.456	7.099
Imports	.517	.621	.628
U.S. Stocks	268.196*	267.858	280.487
Runs to Stills	6.823	6.937	6.781
GASOLINE			
Refinery Output	3.311	3.307	3.224
Refinery Demand	3.429	3.342	3.473
Primary Stocks	178.923*	179.225	147.716
HEATING OILS			
Refinery Output	1.708	1.832	1.754
Refinery Demand	1.888	2.149	1.663
Primary Stocks	74.561*	77.622	81.041
RESIDUALS			
Refinery Output	1.207	1.193	1.219
Imports	.331	.382	.357
Total Suppy	1.538	1.575	1.576
Primary Demand	1.571	1.644	1.659
Primary Stocks	43.265*	43.825	39.572

*Apr. 17.

PRODUCT AND CRUDE PRICES

Products—¢/gal., weighted average prices in principal refinery markets
Crudes—$/bbl., principal fields
Source—Platt's Oilgram Price Service

	Apr. 1954	Mar. 1954	Apr. 1953
Gasoline	11.85	11.77	11.65
Distillates	9.09	9.16	8.69
Kerosine	10.48	10.57	10.17
Residual	3.95	4.01	3.46
Above 4 Products	9.00	8.99	8.68
Lube Oils	16.98	17.03	17.86
Crude	2.82	2.82	2.63

REFINERY YIELDS

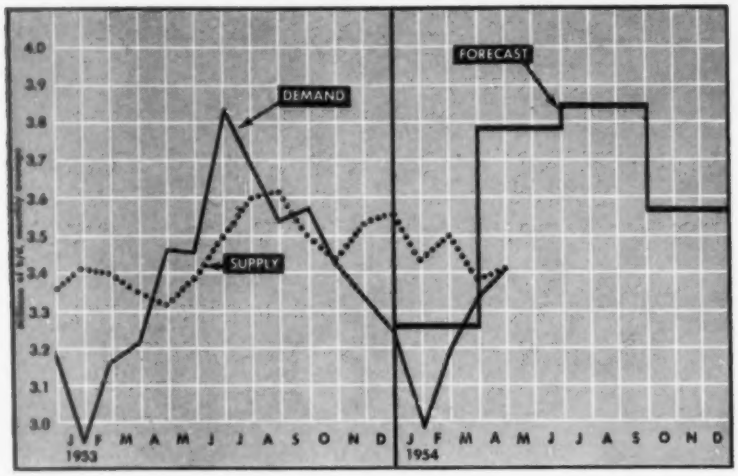
% on Crude Runs to Stills

	Apr. 1954*	Mar. 1954	Apr. 1953
Gasoline	44.3	43.1	43.5
Kerosine	4.7	5.1	5.0
Distillates	20.3	21.3	20.8
Residuals	17.7	17.2	17.9

* Through Apr. 17.

SOURCE OF DATA (except prices): Feb., Mar. and Apr., API weekly reports; earlier months, Bureau of Mines.

Early Spring Gasoline Demand Sluggish



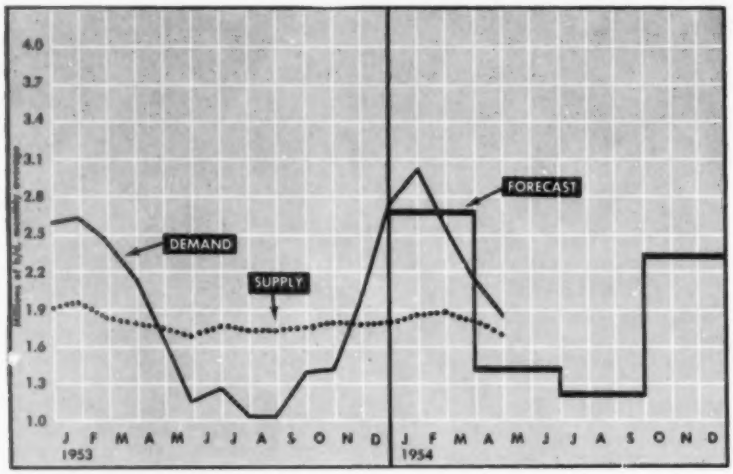
MOTOR FUEL

SUPPLY (Millions of b/d)	From Crude	From Nat. Gas	Total
Apr. '54*	3.021	.390	3.411
Apr. '53	2.955	.367	3.322
Change	+.066	+.023	+.089
% Change	2.2	6.2	2.7
TOTAL SUPPLY (Millions of bbls.)			
3 Mos. '54	274.280	35.652	309.932
3 Mos. '53	269.937	35.493	305.430
Change	+4.343	+.159	+4.502
% Change	1.6	0.4	1.5

DEMAND (including Exports) (Millions of b/d)	
Apr. '54*	3.429
Apr. '53	3.473
Change	—.044
% Change	1.3
TOTAL DEMAND (including Exports) (Millions of bbls.)	
3 Mos. '54	285.773
3 Mos. '53	278.974
Change	+6.799
% Change	2.4

* Through Apr. 17.

Normal Decline in Heating Oil Demand

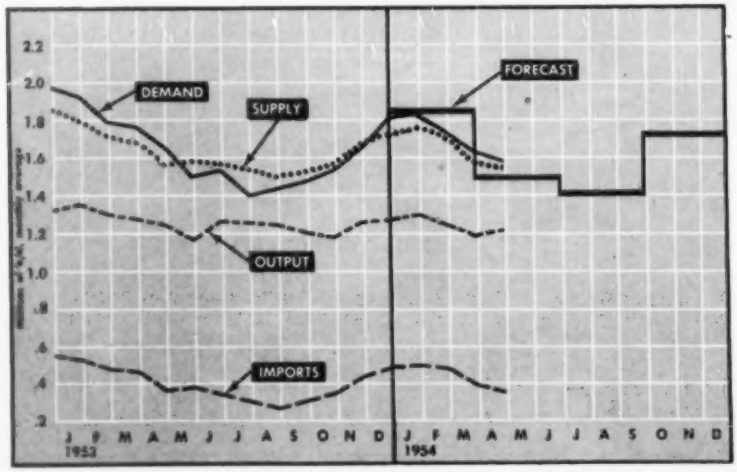


HEATING OILS

PRODUCTION (Millions of b/d)	Kerosine	Dist. Fuels	Total
Apr. '54*	.320	1.388	1.708
Apr. '53	.340	1.414	1.754
Change	—.020	—.026	—.046
% Change	5.9	1.9	2.6
TOTAL PRODUCTION (Millions of bbls.)			
3 Mos. '54	34.319	134.353	168.672
3 Mos. '53	34.740	134.693	169.433
Change	—.421	—.340	—.761
% Change	1.2	0.3	0.4
DEMAND (including Exports) (Millions of b/d)			
Apr. '54*	.324	1.564	1.888
Apr. '53	.287	1.376	1.663
Change	+.037	+.188	+.225
% Change	12.9	13.7	13.5
TOTAL DEMAND (including Exports) (Millions of bbls.)			
3 Mos. '54	45.010	187.879	232.889
3 Mos. '53	43.631	175.682	219.313
Change	+1.379	+12.197	+13.576
% Change	3.2	6.9	6.2

* Through Apr. 17.

Residual Supply—Demand Sloping Off



RESIDUAL FUELS

SUPPLY (Millions of b/d)	Refinery Output	Imports	Total
Apr. '54*	1.207	.331	1.538
Apr. '53	1.219	.357	1.576
Change	—.012	—.026	—.038
% Change	1.0	7.3	2.4
TOTAL SUPPLY (Millions of bbls.)			
3 Mos. '54	110.881	40.333	151.214
3 Mos. '53	115.150	41.318	156.468
Change	—4.269	—.985	—5.254
% Change	3.7	2.4	3.4

DEMAND (including Exports) (Millions of b/d)	
Apr. '54*	1.571
Apr. '53	1.659
Change	—.088
% Change	5.3
TOTAL DEMAND (Including Exports) (Millions of bbls.)	
3 Mos. '54	156.059
3 Mos. '53	164.999
Change	—8.940
% Change	5.4

* Through Apr. 17.

SOURCE OF DATA: Feb., Mar. and Apr., API weekly reports: earlier months, Bureau of Mines.

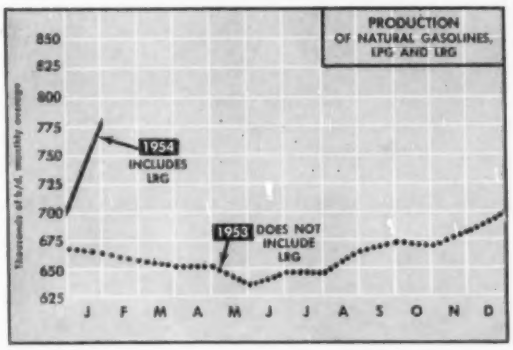
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U.S. REFINERY DISTRICTS

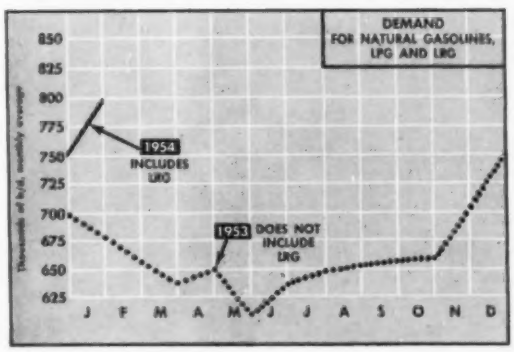
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Apr. 17 1954	Apr. 18 1953	Change	% Change	GASOLINE STOCKS (Millions of bbls., on date shown) Apr. 10 1954	Apr. 11 1953	Change	% Change	RESIDUAL STOCKS (Millions of bbls., on date shown) Apr. 10 1954	Apr. 11 1953	Change	% Change
East Coast	1.001	.967	+ .034	3.5	37.113	34.793	+ 2.320	6.7	8.578	9.984	−1.406	14.1
Gulf Coast	2.309	2.192	+ .117	5.3	32.402	29.584	+ 2.818	9.5	5.590	7.706	−2.116	27.5
Total Coastal	3.310	3.159	+ .151	4.8	69.515	64.377	+ 5.138	8.0	14.168	17.690	−3.522	19.9
Appalachian	.189	.178	+ .011	6.2	6.975	5.662	+ 1.313	23.2	.955	.570	+ .385	67.5
Ind.-Ill.-Ky.	1.224	1.169	+ .055	4.7	40.653	36.251	+ 4.402	12.1	4.241	3.411	+ .830	24.3
Okla.-Kans.-Mo.	.595	.562	+ .033	5.9	20.111	18.390	+ 1.721	9.4	1.245	1.247	− .002	0.2
Other Inland	.541	.540	+ .001	0.	19.824	16.554	+ 3.270	19.8	2.115	1.899	+ .216	11.4
Total Inland	2.549	2.449	+ .100	4.1	87.563	76.857	+10.706	13.9	8.556	7.127	+1.429	20.1
Total East of Calif.	5.859	5.608	+ .251	4.5	157.078	141.234	+15.844	11.2	22.724	24.817	−2.093	8.4
California	1.056	1.078	− .022	2.0	22.651	18.659	+ 3.992	21.4	21.109	15.846	+5.263	33.2
Total U.S.	6.915	6.686	+ .229	3.4	179.729	159.893	+19.836	12.4	43.833	40.663	+3.170	7.8

District	DISTILLATE STOCKS (Millions of bbls., on date shown) Apr. 10 1954	Apr. 11 1953	Change	% Change	KEROSINE STOCKS (Millions of bbls., on date shown) Apr. 10 1954	Apr. 11 1953	Change	% Change	TOTAL HEATING OIL STOCKS (Millions of bbls., on date shown) Apr. 10 1954	Apr. 11 1953	Change	% Change
East Coast	18.782	20.375	−1.593	7.8	7.274	8.256	− .982	11.8	26.056	28.631	−2.575	9.0
Gulf Coast	8.562	10.950	−2.388	21.8	3.709	3.526	+ .183	5.2	12.271	14.476	−2.205	15.2
Total Coastal	27.344	31.325	−3.981	12.7	10.983	11.782	− .799	6.8	38.327	43.107	−4.780	11.1
Appalachian	1.335	1.349	− .014	1.0	.653	.726	− .073	10.1	1.988	2.075	− .087	4.2
Ind.-Ill.-Ky.	8.689	8.879	− .190	2.1	3.432	3.594	− .162	4.5	12.121	12.473	− .352	2.8
Okla.-Kans.-Mo.	6.184	6.456	− .272	4.2	.970	1.161	− .191	16.5	7.154	7.617	− .463	6.1
Other Inland	4.032	3.758	+ .274	7.3	.828	1.046	− .218	20.8	4.860	4.804	+ .056	1.2
Total Inland	20.240	20.442	− .202	1.0	5.883	6.527	− .644	9.9	26.123	26.969	− .846	3.1
Total East of Calif.	47.584	51.767	−4.183	8.1	16.866	18.309	−1.443	7.9	64.450	70.076	−5.626	8.0
California	10.188	8.926	+1.262	14.1	.403	.376	+ .027	7.2	10.591	9.302	+1.289	13.9
Total U.S.	57.772	60.693	−2.921	4.8	17.269	18.685	−1.416	7.6	75.041	79.378	−4.337	5.5

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d, monthly average)	Jan. 1954	Dec. 1953	Jan. 1953
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	355	344	319
Natural Gasoline and Isopentane	248	253	246
Condensate	26	28	24
Finished Gasoline, Naphtha and Others	59	75	76
Total Natural Gasoline and Cycling Plant Production	688	700	665
Liquefied Refinery Gases	91	*	*
Total Marketable Gas Liquids	779	700	665
Lease Condensate	97	94	91
Total Natural Gas Liquids	876	794	756

CUMULATIVE PRODUCTION (1000 bbls.)	Jan. 1954	Jan. 1953
LPG and LRG	13,829	10,043*
Natural Gasoline, Isopentane and Others	10,320	10,574
Total Marketable Gas Liquids	24,149	20,617

CURRENT DEMAND (1000 b/d monthly average)	Jan. 1954	Dec. 1953	Jan. 1953
LPG and LRG	457	368*	336*
Natural Gasoline, Isopentane and Others	340	383	340
Total Current Demand	797	751	676

CUMULATIVE DEMAND (1000 bbls.)	Jan. 1954	Jan. 1953
LPG and LRG	14,163	10,408*
Natural Gasoline, Isopentane and Others	10,557	10,544
Total Cumulative Demand	24,720	20,952

STOCKS (1000 bbls., end of Month)	Jan. 1954	Dec. 1953	Jan. 1953
LPG and LRG	4,143	3,688*	1,692*
Natural Gasoline, Isopentane and Others	4,648	4,885	3,888
Total Stocks at Plants and Terminals	8,791	8,573	5,580

*LRG not reported.

...from billet to tube to fitting

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GLOBE highly specialized process controls are used to produce the finest in WELDING FITTINGS

For complete information on the finest welding fittings available anywhere, send for the Globe Welding Fittings Catalog.

Globe precision-process manufacture *begins with the billet* — continues through the making of the seamless steel tube — (Globe alone among welding fitting manufacturers produces seamless steel tubes) — and extends through to the production of the finished fittings.

Because Globe has highly specialized controls — at every stage of manufacture *in its own plant* — you can be sure of uniform high quality seamless welding fittings when you specify Globe.

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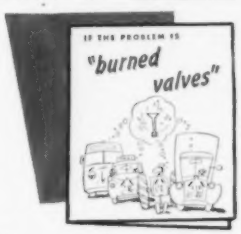
Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high purity ingot iron) seamless tubes — Globe Welding Fittings.

PETROLEUM CHEMICALS DIVISION
NEWS

May ★ One of a Series of Interest to the Petroleum Industry ★ 1954



Burned valves are rarely the fault of the fuel or oil

Yet, your fleet and farm account salesmen often have to take the brunt of valve-burning complaints. Now, the 4-page, pocket-size folder shown above can help you and your representatives get off the hook on these complaints.

Graphically illustrated by cartoon drawings, this folder explains why most valve troubles are the result of improper engine maintenance and operation. It discusses carburetor mixture settings, cooling system troubles, valve seating and other factors contributing to valve burning. Involved technical discussions are avoided. The copy is clear, simple and easy to remember.

For sample copies and information on how to obtain "burned valves" folders for your salesmen, ask a Du Pont representative or write to any Du Pont Petroleum Chemicals Division regional office.

Jet Fuel Research Program Initiated At Petroleum Laboratory

As the jet age advances at a fast pace, refiners are being confronted with new problems involving the combustion characteristics of jet fuels.

Operator at the control panel of the "Jet Room" in the Du Pont Petroleum Laboratory.

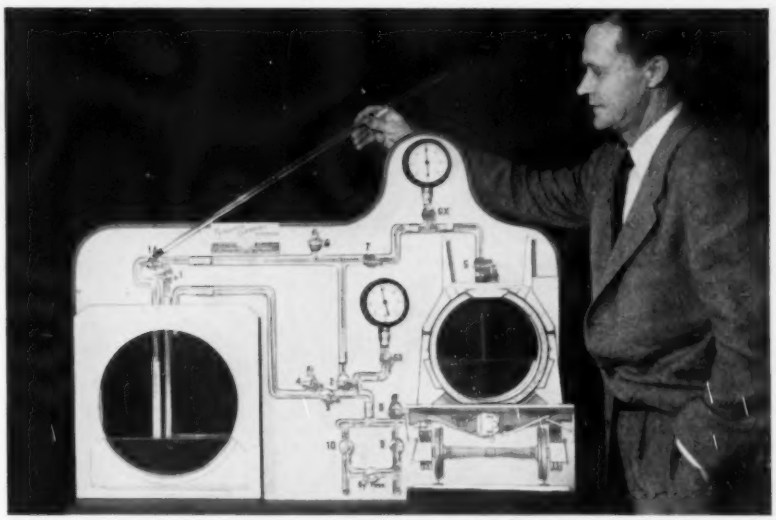
To help in the solution of these problems, the Du Pont Petroleum Laboratory has added new facilities for jet fuel research. These are currently being employed to study the effects of various additives for improving the performance of jet fuels. The present investigations are concentrated on three of the most pressing problems . . . (1) carbon deposition, (2) nozzle clogging, and (3) smoke.

This work on jet fuel additives is part of an extensive research program at the Petroleum Laboratory and other associated Du Pont laboratories.

Du Pont Develops Syphon Starter To Overcome Tetraethyl Lead Tank Car Unloading Problems

Syphon breaks caused by leaks in the vacuum system used for unloading TEL tank cars pose troublesome unloading problems. The development four years ago of the Du Pont Metal-Flex unloading hose has helped to overcome most of the difficulties where smaller weigh tanks are used.

However, the current use of larger weigh tanks and gasoline of higher Reid Vapor Pressure has, in many cases, made it difficult and often impossible to create enough vacuum to unload the bottom portion of the tank car directly into the weigh tank. This difficulty generally results in considerable loss of time and efficiency.



Tank car unloading operations are exactly simulated by this scale model. The weigh tank is on the left and the tank car on the right. Mercury is used in the model to simulate tetraethyl lead compound.

But it is now possible to solve this unloading problem quickly and easily with the aid of a specially-designed "syphon starter."

Developed by Du Pont

Du Pont engineers and technical representatives were frequently called upon for help in solving unloading difficulties at customer plants. Determined to lick the problem, one of these men went to work and came up with the solution.

As a result, a new Du Pont-designed standpipe that acts as a syphon starter was developed.

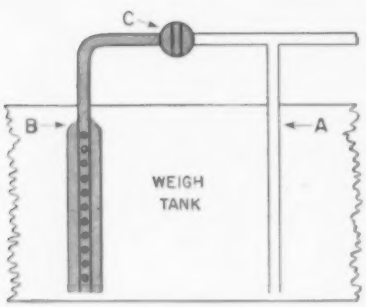
OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED

Syphon Starter



This diagram explains the basic principles in the Du Pont syphon starter system. "A" represents the standard standpipe. "B" indicates the perforated standpipe and shield. "C" is the syphon starter valve.

Getting the last drop

Suppose you have a weigh tank which you would like to fill to capacity. You can unload one tank car of TEL compound into it quite readily. But by the time you work down to the "heel" of the second carload, your troubles begin. Only too frequently that last 1,000 lbs. or so of TEL compound just won't syphon out of the tank car.

What has happened? For some reason or other, your syphon has broken. This is most likely caused by air getting into the system from a packing gland leak around a valve or a vortex forming in the compound at the bottom of the tank car.

When the syphon breaks at this point, it is generally difficult and often practically impossible to re-establish it.

What can you do?

In the past, any one of several alternatives has had to be employed to finish the unloading operation. One is by priming the line. You re-establish the syphon by bleeding in gasoline from the circulating system. The disadvantage of this method is, of course, that the TEL compound is diluted and your blending formula upset.

Sometimes it is possible to prime the line by an elaborate manipulation of valves which alternately connect the tank car to the eductor and then to the weigh tank. This method usually requires several operators and may put compound directly into the gasoline instead of the weigh tank.

On the other hand, you might choose to take the TEL directly from the tank car into your circulating gasoline system. But here again your blending calculations are upset and have to be refigured.

Another alternative would be to transfer some of the TEL compound out of the weigh tank and into some other storage tank.

But all of these methods result in a waste of man hours and a loss in refinery efficiency.

The Starter

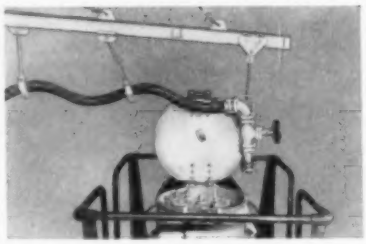
Now, whenever your syphon breaks at a point where it is difficult to get started again, the Du Pont syphon starter comes to your rescue.

The starter itself is an auxiliary standpipe. But it differs from the standard standpipe in that it is perforated. This means that it takes full advantage of the vacuum above the liquid level.

But being perforated, the standpipe has to be designed to prevent the build-up of a static charge which could be explosively dangerous since there is a chance that a gasoline and air mixture may be present in the tank. To guard against this danger, the perforated pipe is surrounded by an outer shield of tubing. The two units are welded together with a series of bracer members.

Because of its potential for increasing unloading efficiency, you will want to know more about the new Du Pont-designed syphon starter. We suggest you discuss it with a Petroleum Chemicals representative, or address your request for further details to the regional office of the Petroleum Chemicals Division in your area.

Metal-Flex Unloading Hose Another Du Pont Contribution To The Eductor System



In TEL tank car unloading operations, leaks—although they may allow only a small amount of air to enter the vacuum system—are the most common cause of syphon breaks.

It was to help prevent these leaks—as well as to add convenience to unloading operations — that Du Pont developed the Metal-Flex unloading hose several years ago. Because of its easy flexibility, it eliminates the binding which tends to cause gland leaks on rigid lines. This also eliminates the need for many costly, hazardous gland repacking jobs.

In fact, hardly any maintenance is required to keep the hose in working condition. This, added to the fact that only one man is required to connect and operate it, means that the Metal-Flex installation more than pays for itself in added efficiency within a very short time.

DU PONT

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Petroleum Chemicals

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A-7240

Printed in U. S. A.

"THE BRAND OF PROGRESS"

By Heat Exchanger Specialists

▲SYNOPSIS OF AD NO. 2: Although Western Supply Company serves the petroleum, chemical and petro-chemical industries nation-wide, the company's physical plant is limited. These limitations, however, have been carefully planned to offer Western's customers a flexible service in heat exchanger fabrication from both common and alloy metals. Although not the largest, Western is recognized as one of the most modernly equipped heat exchanger plants in the country.

Ivy covered walls for better HEAT EXCHANGERS

In an effort to add to the knowledge and technology of heat transfer, Western Supply sponsors research at the internationally known Petroleum Sciences College at the University of Tulsa. Heat transfer rates are carefully studied using various fluids under a wide range of temperatures and pressures. With equipment installed by Western, students and professors may study boiling, condensing, forced convection transfer rates and fouling characteristics.

This, however, is but one phase of Western's continuous research program. In addition, the company is an active participant in the studies of the Tubular Exchanger Manufacturers Association. For several years TEMA, in cooperation with other technical groups, has been conducting tests on shell-side transfer rates using equipment installed at the University of Delaware. Metallurgy, too, is studied by Western technicians and an experienced metallurgist of over 25 years experience consults daily with Western Engineers on welding, heat treating and corrosion problems as well as exchanger structural design.

The above is a brief summary of Western's research program . . . a program designed and carried on to offer you, the customer, the benefits of better design, better construction for increased operating efficiency and longer life for your Western Heat Exchangers.

Third in a new series of advertisements

WESTERN
HEAT EXCHANGERS

WESTERN SUPPLY CO.

P. O. BOX 1888 • TULSA, OKLAHOMA

(To obtain more data on advertised products see page 776)

15 YEAR FAVORITE

DEPENDABLE

RUGGED

EASY, LOW COST MAINTENANCE

SIMPLE ADJUSTMENTS

VERSATILE

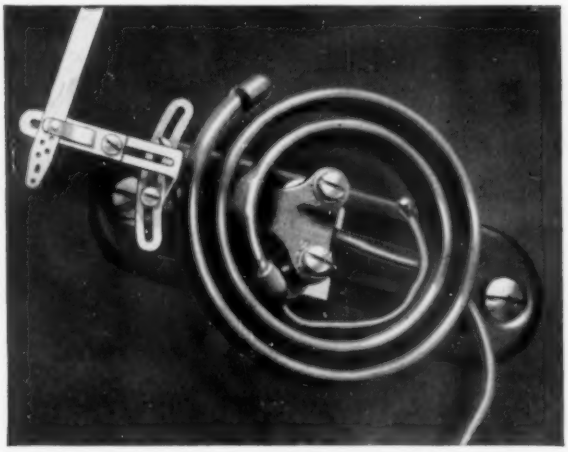
TROUBLE-FREE

SIMPLE OPERATION

LONG LIFE

Single Duty FULSCOPE Recording Controller with Adjustable Sensitivity, Automatic Reset and PRE-ACT responses. Double Duty control mechanisms, with *any* combination of control responses, afford a great advantage on many applications.

Sensitivity adjustment unit; single, continuous adjustment calibrated in specific units.



Improved sub-base permits easy, precise replacement of pre-calibrated actuating systems in field.

(To obtain more data on advertised products see page 776)

IN GASOLINE PLANTS

. . . the Taylor Fulscope® Controller

ITS dependability and accuracy have made the Taylor FULSCOPE Controller specially adaptable to the requirements of natural gasoline plants. Rugged, trouble-free, it can be relied upon to run for hours on end unattended and to give smooth, uninterrupted operation in the production of specification products. Thus the operators are freed for over-all plant supervision and other maintenance duties.

For the benefit of those who are new in positions of responsibility in the selection of instrumentation, here are some of the reasons why Taylor Series 100 FULSCOPE Controllers have been able to meet these exacting requirements and consequently reign supreme throughout industry.

ADAPTABILITY

1. Extremely versatile. The same control mechanisms are available for Temperature, Pressure, Flow and Liquid Level—in either recording or indicating models, as locally mounted controllers, transmitters or controlling receivers. Interchangeable unit construction permits a small inventory of parts. Pre-calibrated units eliminate expensive checking. Easy visibility and accessibility of components means an instrument man can have a unit back on the job with minimum down time.

2. Adaptable to any control problem because the FULSCOPE Controller has three control effects:

(a) Proportional Response—available in three forms: Fixed High Sensitivity (1000 psi per inch pen movement): Adjustable Sensitivity (1000 to 1 psi); and Limited Range Sensitivity (400 to 30 psi). **(b) Automatic Reset Response,** completely and continuously adjustable (.05 to 5 repeats per minute). **(c) PRE-ACT* Response** (rate action) continuously adjustable within the range of 0.2 to 10 mins. All the adjustments are wide range and continuous. Any combination of these control responses may be used to provide any required quality of control. PRE-ACT and reset units are interchangeable.

3. Proper Adjustment Easily Obtained. Control Response Adjustment Dials are calibrated in specific units, repeatable in all instruments. Optimum settings are quickly determined.

4. Controller action simply changed by lifting a spring clip and rotating set-point knob.

DEPENDABLE OPERATION

5. Control point always matches set point when automatic reset is used, thanks to fully pneumatic sensitivity reduction. Lowering sensitivity for stability does not reduce the effectiveness of the reset response. Result—control point always returns to set point, regardless of load changes.

6. Trouble-free air system. Metal disc type filters are built-in features, easily removed for cleaning. Both relay air valve and nozzle are made of 18-8 stainless steel. A simple system, made of corrosion resistant parts, easily accessable for cleaning.

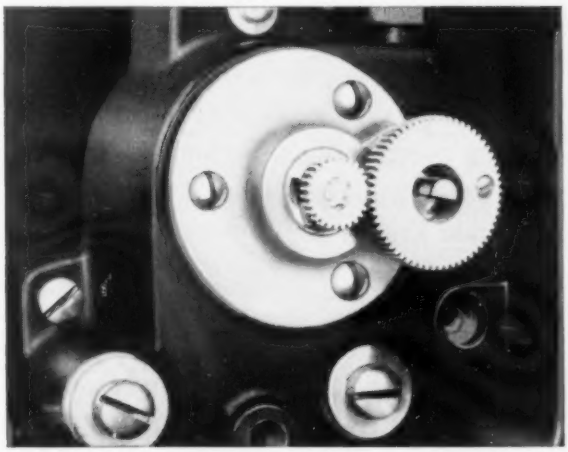
7. Lifelong Accuracy. Fewer links and pivots. Dead spot and hysteresis practically non-existent due to lightweight stainless steel link and small diameter burnished pivots. This lightweight construction nullifies vibration effects. Spring pivot clips, which do not gum up or corrode, replace screws. Over and under-range linkage protection provided when required.

Whether your processing problems are simple or complex, there's a Taylor instrument or control system and a competent Taylor Field Engineer ready to help you solve them.

Write for Bulletin 98151. Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

*Trade-Mark



Interchangeable needle valves in Automatic Reset and PRE-ACT units.

Taylor Instruments
MEAN ACCURACY FIRST

(To obtain more data on advertised products see page 776)

ANOTHER CALSTEEL COLUMN FABRICATION JOB!

Stanolind Oil and Gas Company
Elk Basin, Parks County, Wyoming

CALSTEEL

ENGINEERED FABRICATION

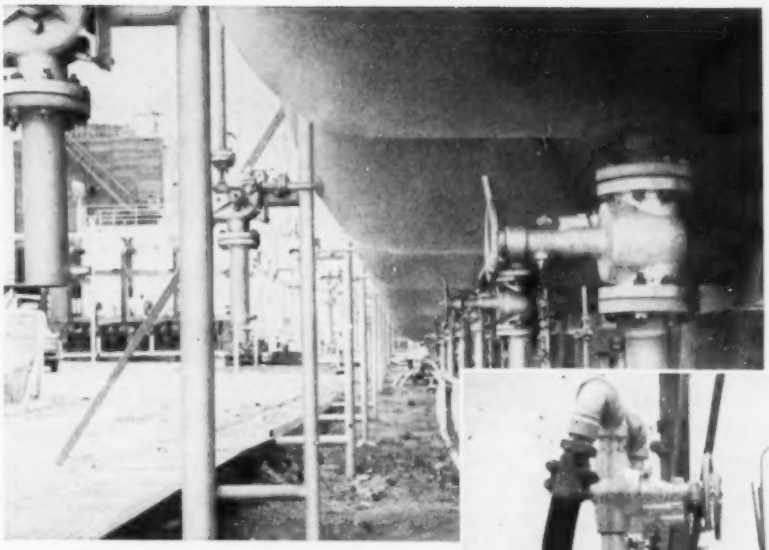
STEEL and ALLOY PLATE
STRUCTURAL · PIPE
for the
Process, Oil, Gas
Atomic Energy and
Power Industries

● The contributions of CALSTEEL to this installation demonstrate the company's precision execution of the most exacting specifications. Because they are custom made to individual requirements, CALSTEEL fabrications "fill the bill" completely for the Process, Oil, Gas, Atomic Energy and Power Industries. CALSTEEL does a superior job of *custom engineered fabrication.* Call on CALSTEEL to fill your fabrication needs!

CALIFORNIA STEEL PRODUCTS COMPANY

DIVISION OF AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES: RICHMOND, CALIFORNIA • PLANTS IN RICHMOND, CALIF. & NORTH TONAWANDA, N. Y.
District Offices: San Francisco · New York · Chicago · Philadelphia · Pittsburgh · Cleveland · Detroit · Buffalo



ORBIT VALVES ®

For SAFER Handling of LP-Gas from Plant to Loading Rack

Void areas are eliminated in the body of Orbit Valves . . .

A cross section view is furnished to show this important feature. When the valve is closed it drains clean to either side of the line. Orbit's Friction Free Seating principle gives a positive shut-off on both the down stream and up stream end of the valve. A simplified but rigid control mechanism makes this possible. The seat is vapor tight when closed.

The body is vapor tight too because both body and bonnet are made of dropped forged steel — the bonnet is welded to the body to form an integral unit.

Orbit Forged Steel LP-Gas Valves are rising stem type with adjustable plastic stem packing. Full Round opening type in sizes 1″ to 4″ Flanged or Screw end, ASA Class. Maximum rated working temperature 250 Degrees Fahrenheit.

For Fast Regional Service call ORBIT'S Offices located in —

HOUSTON, TEXAS	407 Velasco (Serving the Gulf Coast)
ODESSA, TEXAS	402 West County Road (Serving West Texas)
CASPER, WYOMING	247 W. First Street (Serving the Rocky Mountain States and Canada)

ORBIT VALVE COMPANY

P. O. BOX 699 TULSA, OKLA.

Where *is "Lead" used*

to control Sulphuric Acid Corrosion?

Find H_2SO_4 and you're apt to find lead.

Lead's fought H_2SO_4 corrosion for several centuries and its usefulness grows steadily.

The past few years have seen lead go into new types of electrostatic and sonic air purifiers; into new waste treating equipment; bubble towers; devices for processing, recovering and storing sulphuric acid and other chemicals.

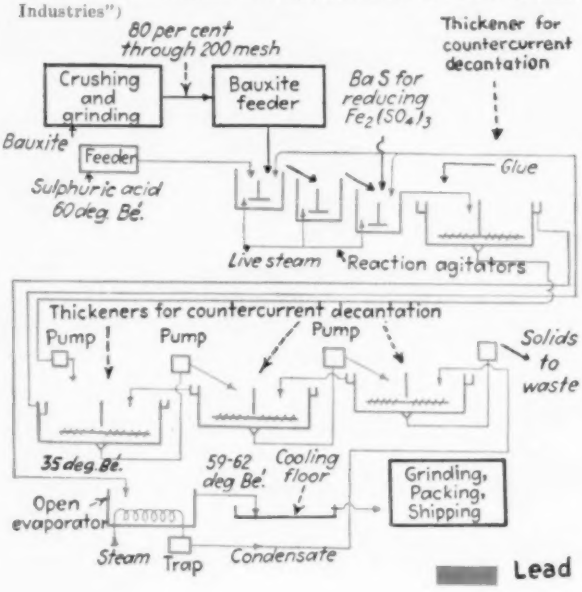
And new forms of cage-type sheet lead structures have been developed... along with new bonding and strap lining methods, new constructions for high temperature erosion-corrosion service, automatic stud welding. New, non-destructive tests for bonds, linings and welds have been devised.

More is coming soon ... coming from research into anodic corrosion of lead in sulphuric solutions ... into lead's age hardening and creep properties ... into unknowns.

What about lead in your own acid handling equipment ... considered in the light of this new lead technology? It's worth thinking about, and ...

Aluminum sulphate.

(From Lee's "Materials of Construction for Chemical Process Industries")



When you think of Lead...

think of National Lead

WHAT GOES FOR LEAD AND H_2SO_4 GOES FOR LEAD AND HUNDREDS OF OTHER CORROSIVES

National Lead puts lead in your hands in any grade you may require and in every conceivable form—sheet, pipe, coils, fittings, valves, pumps and vessels. Or you can have National Lead fabricate lead equipment to your specifications.

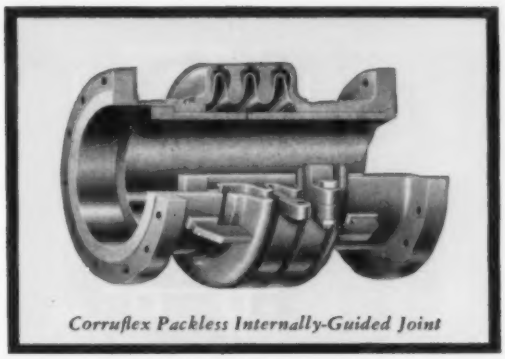
So put National Lead first in your thinking when you want to combat corrosion. Call on National Lead for technical assistance. Ask for a copy of the new booklet on "Chemical Lead Products."

National Lead Company

*Reg. U. S. Pat. Off.

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 80; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Ltd.).

(To obtain more data on advertised products see page 776)

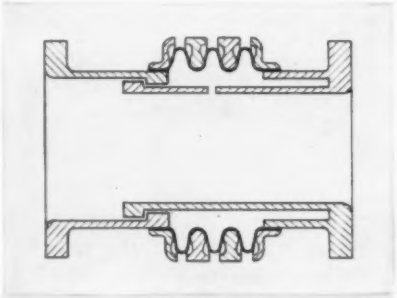


Corruflex Packless Internally-Guided Joint

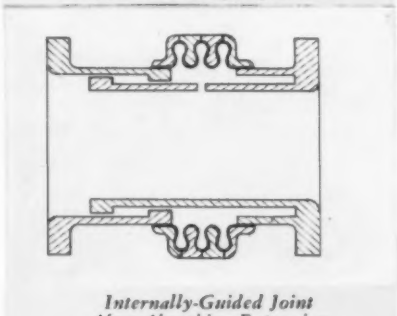
RIGID

AGAINST ALL MOTION EXCEPT AXIAL . . . . .

THE *Corruflex* INTERNALLY-GUIDED JOINT



Internally-Guided Joint Before Absorbing Expansion



Internally-Guided Joint After Absorbing Expansion

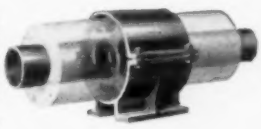
One of many reasons why Corruflex Packless Expansion Joints are so widely used by progressive engineers is the completeness of the Corruflex line. There is a Corruflex joint to absorb pipe expansion under *any* piping condition.

Suppose an engineer wants a joint which provides rigid construction against all movement except axial movement. ADSCO has the perfect solution — the Corruflex Internally-Guided Expansion Joint. No maintenance required because it is packless. Joint is built with an internal sleeve of heavy wall construction for effective guiding. Inner end of sleeve has a guide ring riding on a machined bore to insure true axial movement. Limit stop prevents the joint from being extended beyond its predetermined limit.

ADSCO makes the most complete line of expansion joints of any manufacturer in the world. That means complete engineering! Come to ADSCO for the *right* joint.

Don't let pipes get out of line

Use ADSCO Alignment Guides with ADSCO Expansion Joints. Cylinder is 12" long in all sizes, permitting pipe movement of 10". Damage to insulation prevented by ample clearance between guiding cylinder and pipe.



ADSCO ENGINEERED PRODUCTS

EXPANSION JOINTS • HEAT EXCHANGERS • STEAM TRAPS • STRAINERS • SEPARATORS • METERS

AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES

NORTH TONAWANDA, NEW YORK

PLANTS: NORTH TONAWANDA, N. Y., AND RICHMOND, CALIF.

(To obtain more data on advertised products see page 776)

Pipe cooling water into single oil cooler only—this feature of G.E.'s Type DP turbine saves time and extra piping costs in turbine installation.

ANOTHER PLUS VALUE OF G-E MECHANICAL-DRIVE TURBINES...

Single Oil Cooler Saves Extra Turbine Piping Costs

You save on installation costs with a G-E mechanical-drive turbine because General Electric pipes the bearing oil back to a single reservoir for cooling, in a single oil cooler. This eliminates the extra costs of running cooling water piping to and between each bearing. This feature alone can save you up to $50.00.

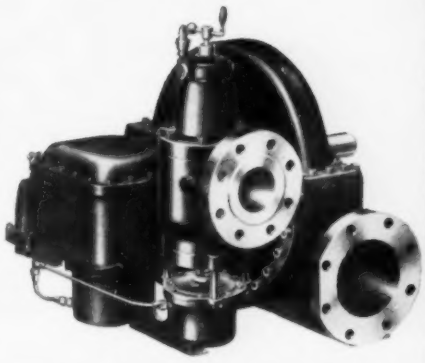
This single oil cooler is just one of the many features on the Type DP turbine which save you money. The chart below indicates other areas of savings.

Remember—the total cost is often more than just the sales price. But G.E.'s standard DP turbines include the extra features that save you extra costs. For more information contact your nearest G-E Apparatus Sales office. Write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." General Electric Company, Schenectady 5, N. Y. 252-64

GENERAL ELECTRIC

INSTALLATION AND MAINTENANCE COST-SAVING FEATURES

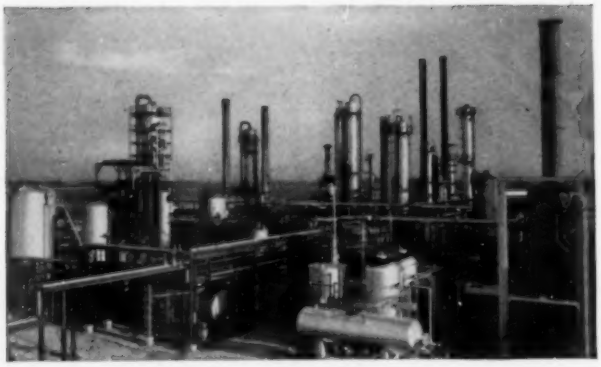
THESE EXTRA FEATURES, STANDARD ON ALL G-E TYPE DP TURBINES, CAN . . .	Save You up to
COMBINED TRIP-THROTTLE VALVE Eliminate extra cost of buying and installing valve ahead of the turbine.	$200.00
SINGLE RESERVOIR FOR COOLING LUBE OIL Eliminate extra cost of piping cooling water to and between bearings.	50.00
MAJORITY OF PARTS INTERCHANGEABLE One set of spare parts protects several units—less money tied up in inventory.	100.00
METALLIC-LABYRINTH VALVE STEM BUSHING Eliminate labor costs of replacing soft packings; cut down-time production losses.	50.00
SHAFT MONEL-SPRAYED AT PACKING FIT Saves frequent cost of purchasing and installing carbon rings; contributes to long shaft and packing life.	20.00
ESTIMATED TOTAL SAVINGS	$420.00



G-E Type DP Mechanical-drive Turbine

COMPARE THE FEATURES
EVALUATE ALL THE COSTS

See why G-E standard Type DP turbines are your most economical buy.



Oh, I see

OIC Valves on the line at Frontier Oil Refining Company, a new refinery at Buffalo, New York.

. . . they're using our valves at Frontier Oil Refining Company

Each valve shown here has qualified for its place in this line because it meets the oil industry standards of modern design, materials, construction and rigid inspection.

Traffic in gallons demands this careful screening. In the long run, it means lower maintenance costs and longer service for OIC Valve users. It's another reason why OIC Valves have gained ready acceptance at Frontier Oil Refining Company and other important oil industry installations.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC FOUNDED 1883

VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON**

(To obtain more data on advertised products see page 776)

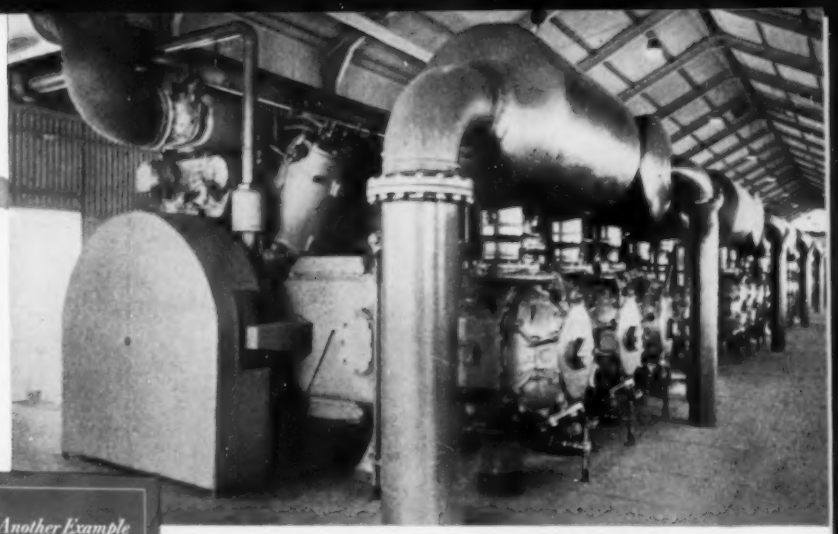
FOR PROCESS COMPRESSING

AT THE DIAMOND "M"-SHARON RIDGE GASOLINE PLANT

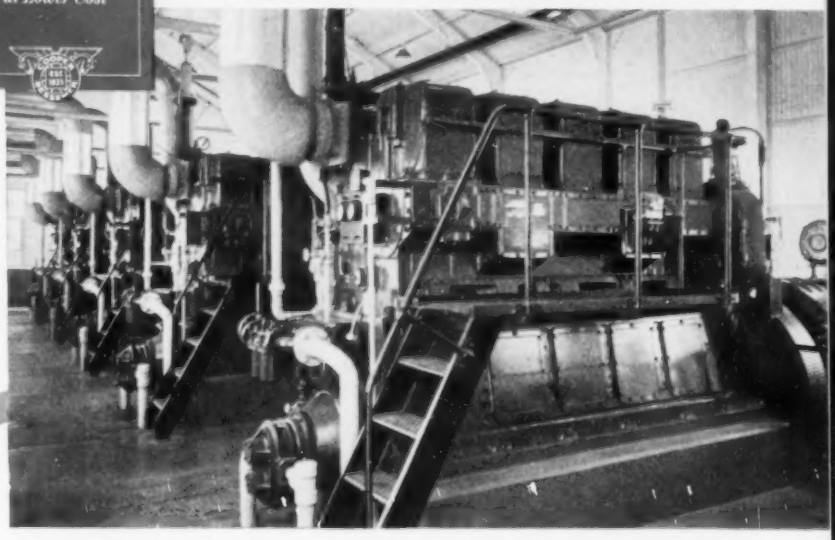
SCURRY COUNTY, TEXAS

Another Example of Efficient Power at Lower Cost

16,080 Cooper-Bessemer horsepower



Above: Some of the Cooper-Bessemer GMV's, now totaling 13,200 compressor horsepower, in the Diamond "M" — Sharon Ridge Gasoline Plant, Scurry County, Texas. *Below:* In this same plant 6 long-lived Cooper-Bessemer 375 horsepower gas engines drive generators for all electrical power requirements.



FOR ELECTRIC GENERATION

• As shown opposite, modern Cooper-Bessemers team up to meet over-all power requirements at the Diamond "M"—Sharon Ridge Gasoline Plant, Scurry County, Texas. This plant now has twelve 1100 HP GMV's, each equipped with three compressor cylinders for 3-stage compression to 525 psi.

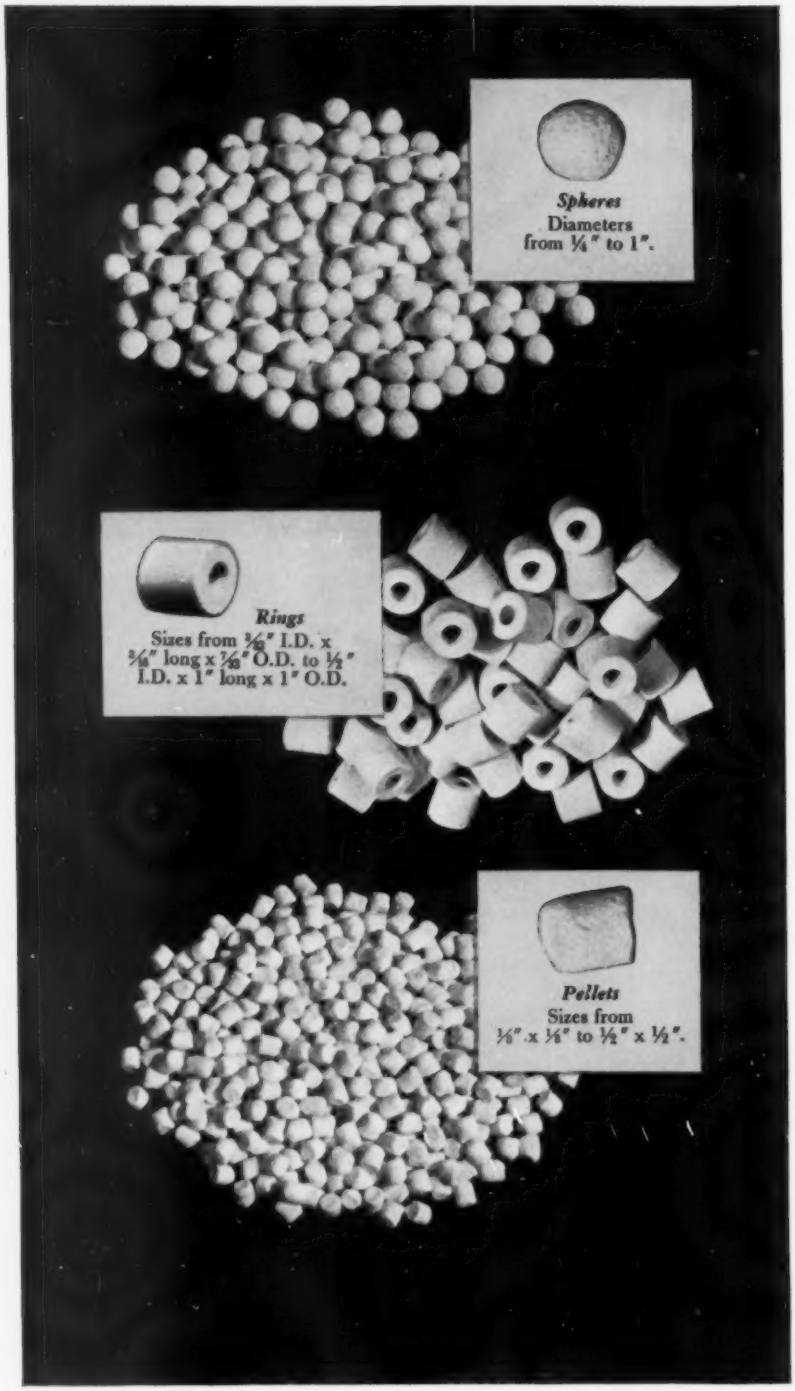
The companies participating in the Diamond "M" have had broad experience with GMV qualities—in other gasoline plants, in major chemical plants and *wherever* large scale compressing demands continuous, low-cost performance. That's one reason—experience—why GMV's were picked for this jointly owned operation.

If your plans call for compressor service, power generation or both, check with the nearest Cooper-Bessemer office on modern units that will keep your costs at a minimum.

COOPER-BESSEMER

MOUNT VERNON, OHIO — PLANTS — GROVE CITY, PENNA.
New York • Chicago • Washington • San Francisco • Los Angeles • San Diego • Houston • Dallas • Odessa • Pampa • Greggton • Seattle • Tulsa • St. Louis • Gloucester • New Orleans • Shreveport
Cooper-Bessemer of Canada, Ltd., Edmonton, Canada

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS • HIGH PRESSURE LIQUID PUMPS

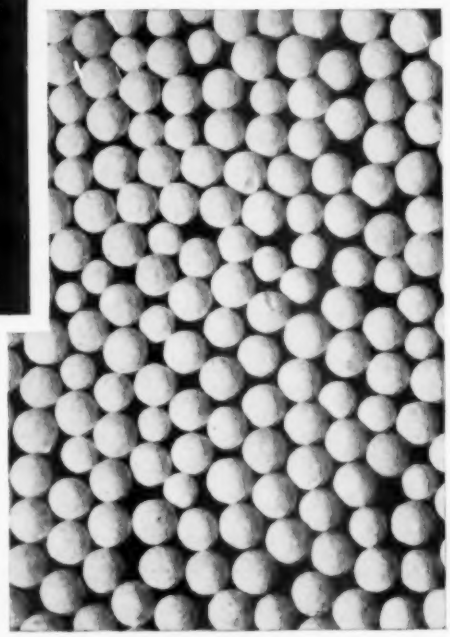


Rx for

Norton catalyst carriers — spheres, pellets and rings — are commercially available in ALUNDUM*, (fused alpha alumina) mixtures. Experimental quantities are available in MAGNORITE*, FUSED STABILIZED ZIRCONIA, CRYSTOLON* and MULLITE.

Norton spherical carriers provide uniform beds in catalytic converters, reducing channeling and pressure drop to a minimum. Medium porosity spheres have porosity ranging from 40% to 44% with a network of open pores on the outside surface only. These are suitable for applications where the carrier is coated with a catalyst. High porosity spheres have porosity ranging from 45% to 49%, with a network of open pores on the outside surface as well as throughout the entire sphere. These are suitable for applications where the carrier is impregnated with a catalyst.

Norton ALUNDUM carriers are proving highly successful in reaction such as those involved in the manufacture of phthalic anhydride, maleic anhydride and oxidation of ethylene. Containing 77% to 89% alumina, they are outstanding for chemical stability and resistance to abrasion and erosion. Write for Bulletin #7, containing additional data on ALUNDUM catalyst carriers.



Norton heat exchange pebbles are made of ALUNDUM. Because of their high alumina content (over 95%) they are ideally suited for pebble type heaters, where they are important as the heat-transfer medium, whether oxidizing or reducing conditions are encountered.

Their ability to withstand abrasion, impact and repeated heating and cooling makes them ideal for heat exchange beds of either the static or moving type. Their high refractoriness prevents softening or incipient fusion at any point in the upper bed. This keeps them from "bridging" together and causing stoppages in a moving bed. ALUNDUM heat exchange pebbles are available in ¼, ⅝, ⅜ and ½" diameters.

(To obtain more data on advertised products see page 776)

higher production... better processing...lower costs

Norton refractories are engineered for top performance — and prescribed for many chemical applications

For your refractory uses, Norton refractory products are *engineered and prescribed* to give you the best possible Rx — the most effective combination of physical characteristics plus thermal, chemical and electrical properties.

The Rx's you need to improve and economize your processing are ready for you in this complete, top-quality line. For details, including expert technical aid, call in your Norton Refractories Engineer. Meanwhile, write for the fact-filled bulletins, mentioned in this advertisement, that cover your particular requirements for dependable, money-saving refractories. NORTON COMPANY, 264 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Canada.

NORTON

REFRACTORIES

Engineered... Rx... Prescribed

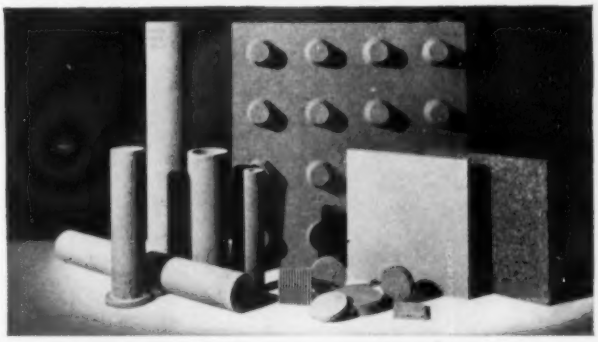
Making better products... to make other products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

Norton electric furnace shapes and laboratory ware

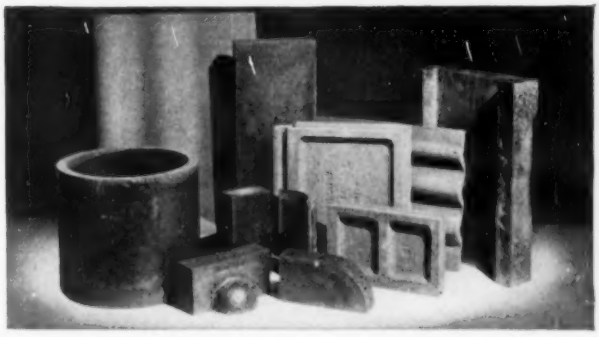
Norton electric furnace refractories — cores, tubes and muffles — are made of ALUNDUM or CRYSTOLON materials. ALUNDUM shapes, composed of 99% pure fused alumina, are characterized by great stability, chemical inertness, excellent thermal conductivity and good electrical insulation qualities. CRYSTOLON shapes, for use under more limited conditions, combine high thermal conductivity with resistance to heat shock. Bulletin No. 458 tells how to construct electrical furnaces for the laboratory.

Norton ALUNDUM laboratory ware, available at your laboratory supply house, offers many properties important to development, experimental or analytical work. It is chemically stable, stands temperatures up to 1900°C and is easy to clean. For filtering, it comes in four degrees of permeability. Bulletin No. 793 gives you the whole story.



Norton porous mediums come in plates, tubes, discs and diaphragms, engineered to fit your filtering, diffusing or aerating requirements. All have uniform porosity, in the size and open-pore ratio you need. Made of ALUNDUM material that is chemically stable and strong. Thus, their resistance both to acid and alkaline conditions gives them extra long life. Norton seamless porous tubes have the advantage, unusual in tubes, of uniform porosity over their entire area — permitting constant air or liquid pressure and enabling uniform backwashing to do more thorough cleaning.

Typical applications are filtering water or solvents; cutting oils, wine and other liquids; reclaiming cleaning fluids; handling industrial oil wastes. Bulletin No. 140 tells you more about Norton ALUNDUM porous mediums.



Norton refractory shapes for reaction furnaces come in bricks, plates, tubes and blocks, made of ALUNDUM, CRYSTOLON, MAGNORITE and FUSED STABILIZED ZIRCONIA refractory materials. The development of FUSED STABILIZED ZIRCONIA is a typical example of how Norton aids you in utilizing higher temperatures for greater efficiency and output. Norton was the first to bring this valuable material out of the experimental stage into commercial production. Now it is used in many processes.

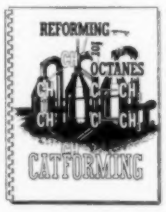
No other refractory is so chemically stable at such high temperatures under both oxidizing and reducing conditions. In gas synthetic processes, furnaces lined with it have withstood temperatures approaching 4700°F for long periods. Its low thermal conductivity (6.2 BTU in dense shapes at 2000°F) and its high electrical conductivity at high heat are other important properties, all of which are described in Bulletin No. 1409.

(To obtain more data on advertised products see page 776)

CATFORMING *means*

High Octanes...
High Yields...
Low Cost...
Proved Performance

These advantages of Atlantic Catforming are being demonstrated again and again in different commercial installations. We invite you to share in the benefits of Catforming. Please phone, write or wire for our detailed brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia, Pa.



ATLANTIC *It's the Catalyst that counts*

SAVED: $120,000 on refinery fabrication with...

KEY-KAST

ALLOY STEEL WELDING FITTINGS

Substantial Savings for Leading Refinery
PLUS These Other Outstanding* KEY-KAST *Benefits

1. Delivery of fittings was on *schedule* with the pipe.
2. Quality of the fittings was consistent throughout, with not one rejection.
3. Although KEY-KAST fittings were *not* ordered to radiographic quality—all weld ends were gamma rayed and KEY-KAST fittings showed up better than class 2 per ASTM E-71.

GIVE YOUR PIPING SYSTEM THE ADVANTAGES OF KEY-KAST ALLOY STEEL WELDING FITTINGS

- Greater wall thickness throughout with *extra* thickness in critical areas.
- Lower unit cost.
- Meet A.S.M.E., A.S.T.M., A.S.A. Codes.
- Rigidly tested and inspected to meet high standards of quality.

IN ALL SHAPES, SIZES, SCHEDULES IN LOW AND INTERMEDIATE ALLOYS AND VARIOUS STAINLESS STEELS

Write for information and prices

key company

Since 1916 . . . manufacturers and developers of products for high temperatures and pressures

P. O. BOX 494-H, EAST ST. LOUIS, ILLINOIS

DISTRICT OFFICES: NEW YORK • CLEVELAND
CHICAGO • TULSA • HOUSTON • LOS ANGELES

600-barrel UOP Platforming unit installed at R. J. refinery near Princeton, Ind.

PLATFORMING CHANGES MARKETING METHODS OF R. J. OIL & REFINING CO.

By Henry P. Smith, President
R. J. Oil & Refining Company, Inc.

HIGH quality products being produced in our new UOP Platforming unit have given R. J. new stature in its marketing area and have brought about sweeping changes in marketing techniques.

Henry P. Smith

Before the Platforming unit went on stream at our refinery near Princeton, Ind., R. J. sold premium and regular gasolines at prices lower than those posted at the wholesale outlets of other oil companies.

Now, because R. J.'s gasolines have the highest octane ratings of any in our marketing area, we are commanding prices on a par with those of other companies. And a new theme song—"Fill 'er up and feel the difference"—is being chanted by motorists patronizing our stations.

Motorists are enthusiastic in their praise of the new "Platolene" premium gasoline and "500" regular—both products of the UOP Platformer.

Gasoline sales have nearly trebled since September 5, 1953, when the Platforming unit went on stream. A credit card system was established recently, and already 200 motorists in the 100-mile area R. J. serves have availed themselves of this service.

First Standard "A" Unit

The process design for the Platforming unit was handled by Universal Oil Products Company engineers. All of the mechanical design and drafting, purchasing, and construction were handled by Procon Incorporated. The unit is the first "package" installation of a Standard "A" UOP Platforming process unit.

The decision to install the Platforming unit was made after careful investigation convinced R. J.'s management that it was the ideal catalytic reforming process which would enable the company to become a leader in a marketing area where the race for higher octanes was constantly increasing.

Other factors which motivated our decision were:

—We felt that Platforming would give R.J. a more marketable product.

—We were convinced R. J. could abandon its below-market price policy because of high quality products without suffering a loss in sales.

—We believed that a Platforming unit would give the refinery sufficient flexibility so that the company could always stay on top in the octane race.

—UOP's long record of giving service to licensees.

R. J.'s Platforming unit is equipped with a desulphurizer. Raw charge consists of 400° F. straight run gasoline which goes from storage to a heater, the desulphurizer and then to a prefractionating column.

A cut of approximately 270° F. end point is removed overhead from the prefractionator. The reactor charge, taken as a sidecut from the prefractionating column, is of 400° F. end point material. The sidecut goes from the reactor charge pump through three heaters and reactors.

Recycle Gas Through Reactor

After passing through the No. 3 reactor, the material is sent to a products separator. The compressor takes suction from the top of the separator and recycles the gas through the reactor section.

The liquid bottoms product from the separator is charged to the stabilizer together with overhead material from the prefractionator. Stabilizer effluent is pumped to storage as marketable products.

Sulphur content of the charge stock is converted in the desulphurizer into H_2S, which in turn is removed from the prefractionator in a net overhead cut. The H_2S is removed overhead when this cut is charged to the stabilizer. Gas from the stabilizer is sent to a gas balance drum before being injected into the refinery fuel gas system.

R. J. has spent nearly $1,000,000 to bring to its motoring public the finest gasoline that can be produced. Because of the increasing demand for our gasoline and other products, we are contemplating an extensive expansion program. Present plans call for doubling the size of the Platforming unit from its present 600 B/SD capacity. It is hoped that this expansion program will be completed by late 1954 or early 1955.

It is our firm belief that Platforming has made R. J. an increasingly important factor in the economic life of southwestern Indiana, and that the company will continue to grow and prosper because of the superior quality of its products made possible by Platforming.

first
600 barrel
UOP Platformer
on stream

designed, engineered and licensed by

UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD,
DES PLAINES, ILL., U. S. A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service
Protects Your *Investment*

(To obtain more data on advertised products see page 776)

which impulse for you?

STANDARD

The standard YARWAY Impulse Steam Trap serves all normal trapping requirements. Factory set to operate without adjustment at all pressures from 20 psi to 400 psi (Series 60) and 600 psi (Series 120). For pressures below 20 psi, merely remove split washer.

Numerous advantages like:

small size
quick heating
steady temperatures
stainless steel construction
one moving part
non-freezing
low cost

More than 900,000 used throughout industry.

Write for YARWAY Bulletin T-1740.

HIGH PRESSURE, INTEGRAL STRAINER

YARWAY Integral Strainer High Pressure Impulse Steam Traps operate on some of the highest pressure steam lines in the country. Same operating principle as the standard YARWAY Impulse Trap. Strainer built into trap.

Ample capacity when system is being "warmed up"—yet will handle relatively small amounts of high temperature condensate without losing prime. Six sizes—½" to 2". Pressures to 1500 psi (flanged ends) or 2500 psi (welding ends).

Write for YARWAY Bulletin T-1740.

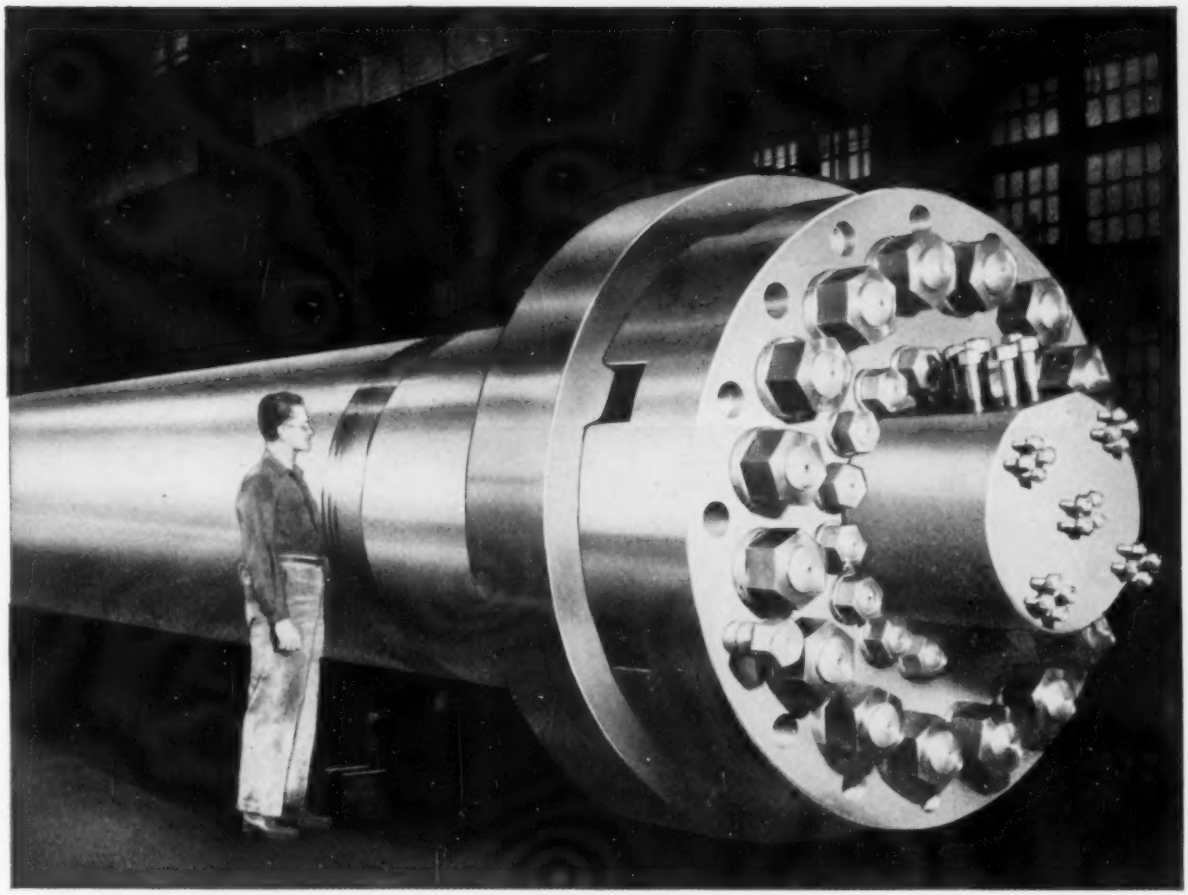
YARNALL-WARING COMPANY
153 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY

impulse steam traps

YARWAY Impulse Steam Traps and Fine Screen Strainers are stocked and sold by more than 250 convenient local distributors. Write for name of one nearest you.

(To obtain more data on advertised products see page 776)



PRESSURE STARTS *Right* AT THE BEGINNING!

Product—Converter
Working Pressure—4,500 P. S. I.
Inside Diameter—45"
Tensile Strength—75,000 P. S. I.
Material—Chrome-Vanadium Steel
Closure—Bridgman
Installation—Union Carbide and Carbon Corp. Texas City, Texas

Midvale pressure vessels are right from the start. Designed right in cooperation with customer's engineers. Made right from the pouring of the steel to final machining. Proved right by extensive sonic, hydrostatic, strain-gage and X-ray tests.

This big brute is an example of Midvale's vast experience and facilities and is the result of complete cooperation in design and building with the engineers of Union Carbide and Carbon Corporation.

This pressure vessel started as a 550,000 pound ingot of chrome-vanadium steel, poured by Midvale's steel making specialists. Then carefully hollow forged to rough shape on 14,000 ton and 7,500 ton presses . . . hydrostatically tested at 9,000 P. S. I. for a working pressure of 4,500 P. S. I. It has been successfully operating for years at Texas City, Texas.

Forged steel converters, reactors, separators, autoclaves . . . any size or type . . . Midvale has the complete facilities and the experienced craftsmen to make them to withstand high pressures, high temperatures and resist corrosion. Next time your plans include pressure vessels get in touch with Midvale. Let our engineers work with you from initial design to final installation.

THE MIDVALE COMPANY- Nicetown, Philadelphia 40, Pa.

Offices: New York, Chicago, Pittsburgh, Washington, Cleveland, San Francisco

MIDVALE

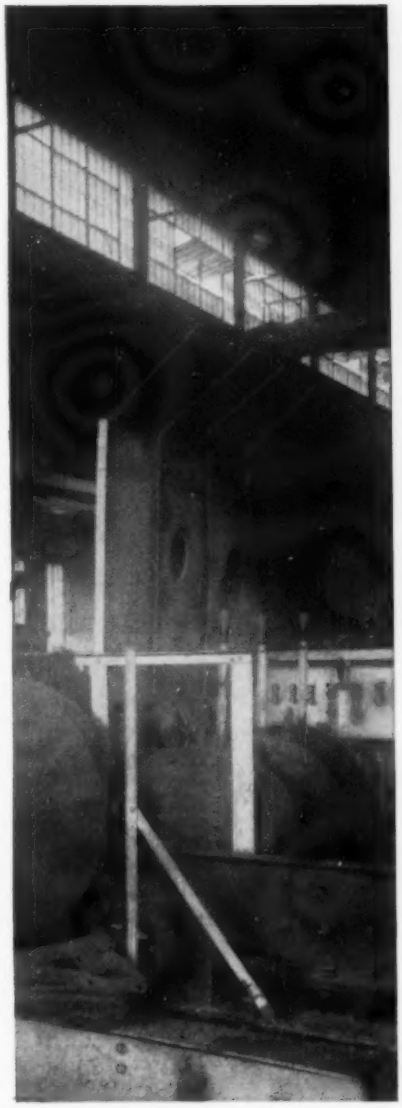
FORGINGS, ROLLS, RINGS, CORROSION AND HEAT RESISTING CASTINGS

Glascote

Where glass weds steel for corrosive service

(To obtain more data on advertised products see page 776)

. . . A NEW A.O.Smith SUBSIDIARY



This is good news to chemical engineers who seek dependable equipment for corrosive service.

The long experience of Glascote technicians in designing and fabricating glass-on-steel processing equipment is now combined with the parallel experience and unmatched research activities of A. O. Smith in ceramics and metallurgy.

Chemical, petro-chemical, pharmaceutical, plastics and synthetics producers will find this amalgamation of great value to them since corrosion-resistant vessels, tanks, kettles, evaporators, exchangers, and the like, have long been produced by both companies. Between them, they are responsible for an enormous volume of glass-lined steel products, including processing equipment, brewery tanks, *Permaglas* water heaters and *Harvestore* crop storage units.

Look to Glascote and *A. O. Smith* for the corrosion-resistant processing equipment you need . . . in standard or custom designs.

Glascote
PRODUCTS, INC.

CLEVELAND 17, OHIO
A subsidiary of A. O. Smith Corporation

Sales offices or agents in Principal Cities
Export Sales: A. O. Smith Corporation, International Division, Milwaukee 1, Wisconsin

(To obtain more data on advertised products see page 776)

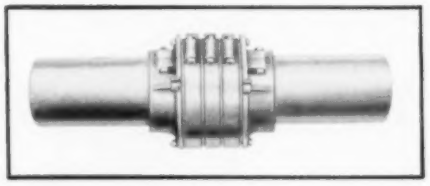
Badger
Expansion Joints

Typifying Joint Engineering at its Best

THE CALCULATED CURVE of the EQUALIZING RING

In the Badger Self-Equalizing Expansion Joint, the solid ring between the adjoining corrugations is more than a mere stop or block. It performs a directing as well as a limiting function. It's part of the Directed Flexing control because its specially calculated curved surface causes the all-curve corrugation to wrap itself around the ring. This distributes the flexing evenly over all parts of the corrugations.

Any design of equalizing ring with shoulders will act as a stop to limit the traverse per corrugation but it takes a special calculated curved surface to distribute the flexing properly. The long service life of the Badger Joint is due in large measure to the fact that all-curve rings aid in directing the flexing and in distributing the traverse as well as limiting the movement exacted from each corrugation.



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Badger Expansion Joints come in a variety of types and a wide range of sizes: Directed Flexing, Self-Equalizing for normal and long traverses and higher pressures; Non-Equalizing, for short traverse or low pressures. Tandem Joints for combination axial and lateral movements; Clevis-Hinged Joints for angular movements; Special Vibration Control Joints; Flexible Pipe Line Seals for water-tight connection between pipes and flood walls.

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET • CAMBRIDGE • MASS.

DESALTING EFFICIENCY FACTOR: SIMPLICITY

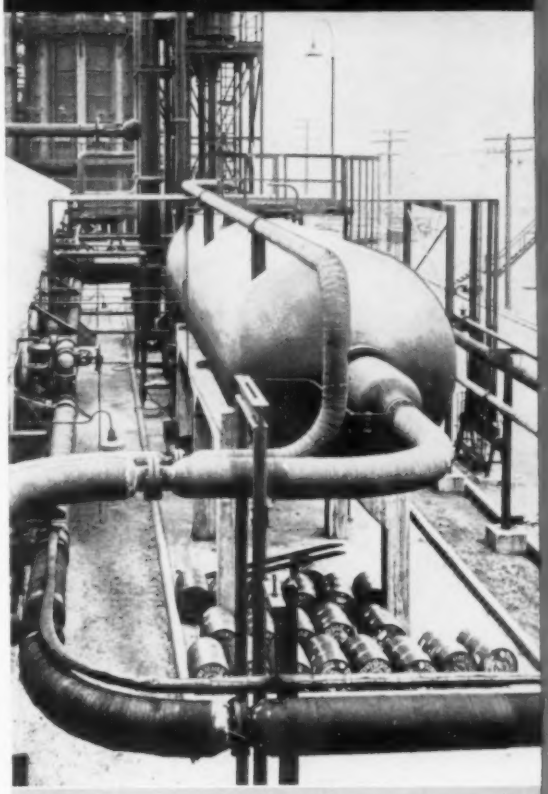
One of the most important features of Tretolite Desalting is SIMPLICITY. Here are three ways it helps you get more efficient desalting.

1. **LOWER INITIAL COST** In a Tretolite chemical desalting plant, Tret-O-lite does the work. The Tretolite-designed flow system promotes ideal coalescence and separation of the oil and water phases. The desalting is effected rapidly and easily.

2. **LOWER OPERATING COST** Tretolite desalting utilizes one agent only, chemical, to effect the salt removal demulsification. The efficiency of Tret-O-lite desalting agents permits effective operation with minimum chemical requirements. No secondary treating agency is required.

3. **LOWER RESIDUAL SALT** In spite of the low initial and installation cost, Tretolite salt removals are in the 95 to 100% range. Residual salts, solids and other impurities are held at minimum. The water bleeds are consistently clean. Tretolite desalting engineers will gladly furnish you with performance data relative to crudes similar to those charged in your refinery.

Why not ask for a Tretolite proposal on your next desalting problem?



TRETOLITE COMPANY

A Division of Petrolite Corporation

369 Marshall Avenue, Saint Louis 19, Missouri

5515 Telegraph Rd., Los Angeles 22, California

Chemicals and Services for the Petroleum Industry

DESALTING • DEMULSIFYING • CORROSION PREVENTING • WATER DE-OILING SCALE PREVENTING • PARAFFIN REMOVING

TD 54-19

PROCON
"OFF-THE-SHELF" DESIGNS
MEAN **Earlier on-stream time**
Accurate cost estimates
Lower engineering costs
Purchasing know-how
Proved construction techniques
Experienced field construction staffs

PROCON Builds Platformer at Pana in 7 Months

Pana Refining Company, a division of the Illinois Farm Supply Company, turned to Procon for speedy construction of the first UOP Platforming unit in the state of Illinois devoted exclusively to the production of superior quality motor fuel.

From the time the contract was signed until Procon turned the completed pressure tested 650 B/SD unit, ready for operation, over to the refinery only seven months and seven days elapsed . . . further proof that "Built by Procon" is the refiner's assurance that his construction will be handled with maximum speed, efficiency, and economy.

Procon has a WIDE RANGE of "off-the-shelf" UOP Platforming units for refiners to choose from, ranging from 600 B/SD to giant 16,000 B/SD plants.

IT'S PLAIN GOOD SENSE for a refiner to use "off-the-shelf" designs when available. He thus has the assurance of earlier on-stream time, accurate cost estimates, lower engineering costs, purchasing know-how, proved construction techniques and experienced field construction staffs for his particular job.

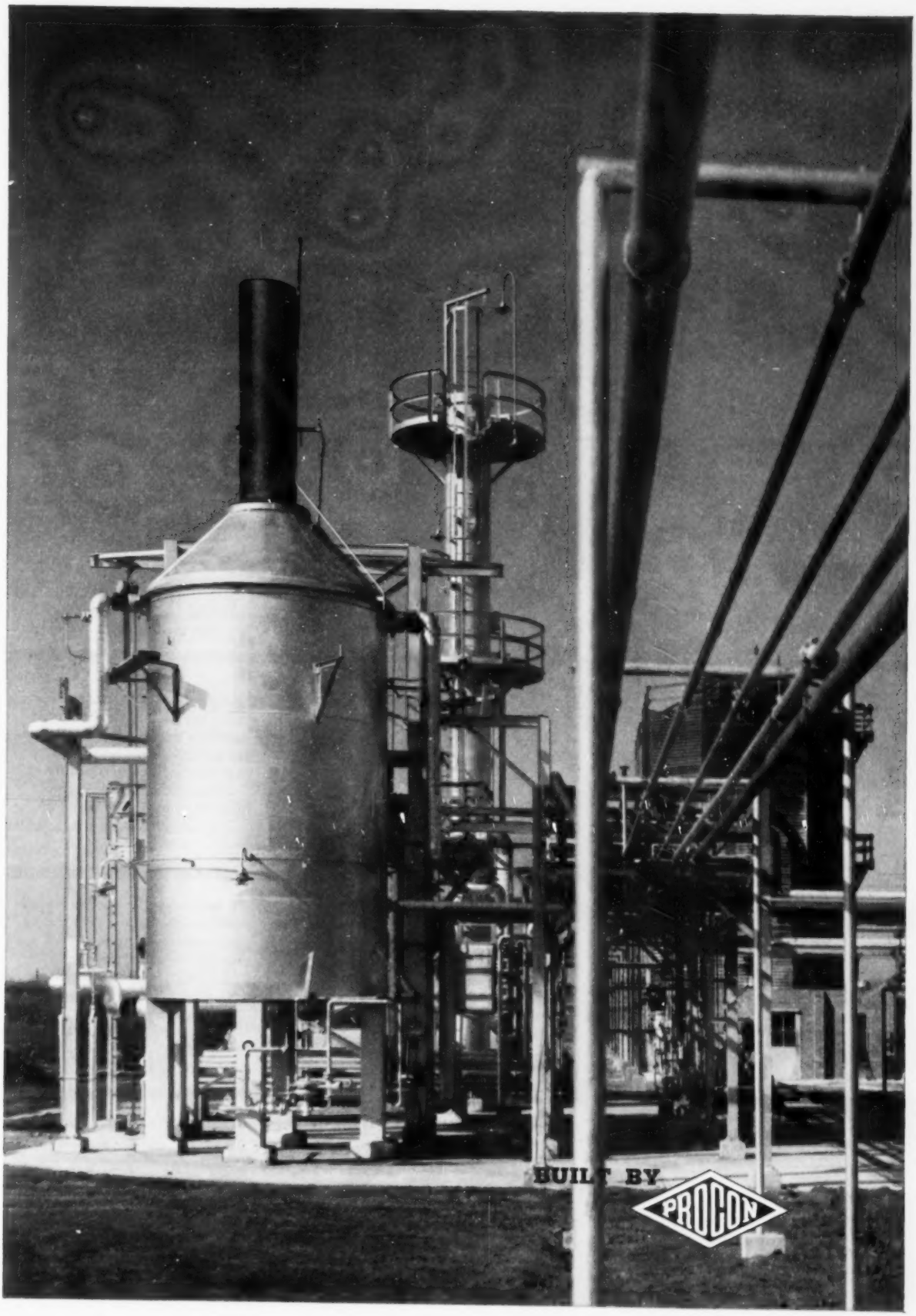
PROCON *Incorporated*

PROCESS CONSTRUCTION

1111 MOUNT PROSPECT RD., DES PLAINES, ILLINOIS, U. S. A.

IN CANADA — PROCON (CANADA) LIMITED, 68 YONGE STREET, TORONTO 1, ONTARIO

IN ENGLAND — PROCON (GREAT BRITAIN) LIMITED, 112 STRAND, LONDON, W. C. 2



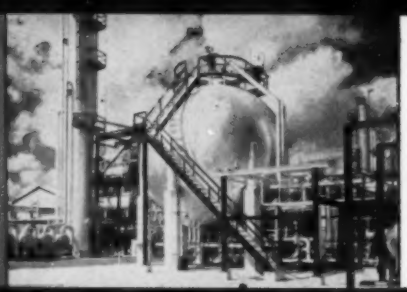
(To obtain more data on advertised products see page 776)

TO INCREASE REFINING EFFICIENCY

PETRECO

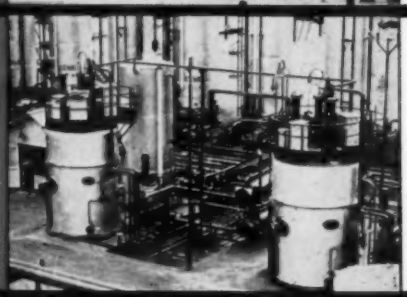
ELECTRIC PROCESSING

DESALTING



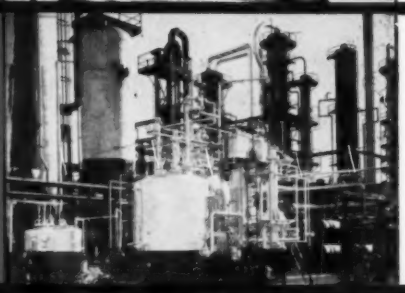
Petreco *Electric* Desalting eliminates salts, solids, and other impurities with such a high degree of efficiency that salt difficulties are eliminated – *enabling refiners to run more crude.*

LUBE OIL TREATING



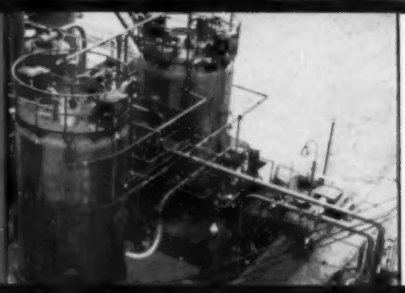
Petreco Lube Oil Treating is an automatic, continuous method for acid-treating lube oils and similar stocks. It is carried on in a closed system, under pressure. High efficiency acid contacting results in minimum acid usage, negligible oil entrainment in sludge, and maximum product quality.

DISTILLATE TREATING



Petreco *Electric* Distillate Treating takes the guesswork out of distillate treating. It is applicable to acid, alkali or doctor treating all distillate stocks. It permits continuous, automatically controlled treating with minimum equipment, handling and attention.

DESAPONIFICATION



Where caustic is added to crude prior to distillation, ash-forming materials resulting from such caustic are often present in fuel stocks. Petreco *Electric* Desaponification removes about 85% of such ash-forming constituents, enabling fuel stock to be marketed or used as a cracking charge.

ELECTRIC
PETROLEUM PROCESSING

DESALTING • DEHYDRATING
SEDIMENT SEPARATING
DISTILLATE TREATING
DESAPONIFYING

PC 53-3

For complete information, call or write

PETRECO

A DIVISION OF PETROLITE CORPORATION

3202 South Wayside Drive, Houston 1, Texas
1390 East Burnett Street, Long Beach 6, California

Here's a new source for caustic soda

If your plant is in this area you can now have liquid caustic soda delivered more rapidly, more dependably, than ever before.

Here's what this new Hooker caustic soda plant at Montague, Mich., means to Midwest industry:

1. **Fast delivery.** You can have caustic soda delivered by tank car, loaded and dispatched within 24 hours of your call. In and near Chicago, tank car deliveries are made from Chicago stocks.
2. **Freight savings.** Depending on locality, you can save up to $2.84 per ton on freight. (To learn specific freight savings to your plant, just phone the Chicago office—CEntral 6-1311.)
3. **Dockside delivery.** On Lake Michigan and adjacent waterways you can have Hooker caustic delivered by barge—a new Hooker service (minimum 250 tons, dry basis). Savings are substantial.
4. **Prompt service you can count on.** At the Hooker sales office, 1 N. LaSalle St., Chicago, men are ready to help you plan efficient handling and storage, meet emergency needs, work out the most economical purchasing and delivery arrangements.
5. **Smoother, better processing.** You can use constant processing methods, and get consistent results with Hooker caustic soda. It's produced under careful control; more than 20 separate inspections and analyses protect its uniformity.

Tighten up your caustic supply line now Many industrial leaders in the Midwest are already enjoying the convenience, economy, and dependable supply of Hooker caustic shipped from Montague.

You can have the same convenience and security *tomorrow*. Just pick up your phone and call us.

Caustic soda for Midwest Industry comes from this new $12 million Hooker plant at Montague, Mich. The plant is built over a tremendous bed of pure salt, which supplies the caustic-producing cells.

FOR FAST SERVICE, phone Chicago—CEntral 6-1311
SALES OFFICE: 1 N. LaSalle St., Chicago 2

HOOKER® CHEMICALS

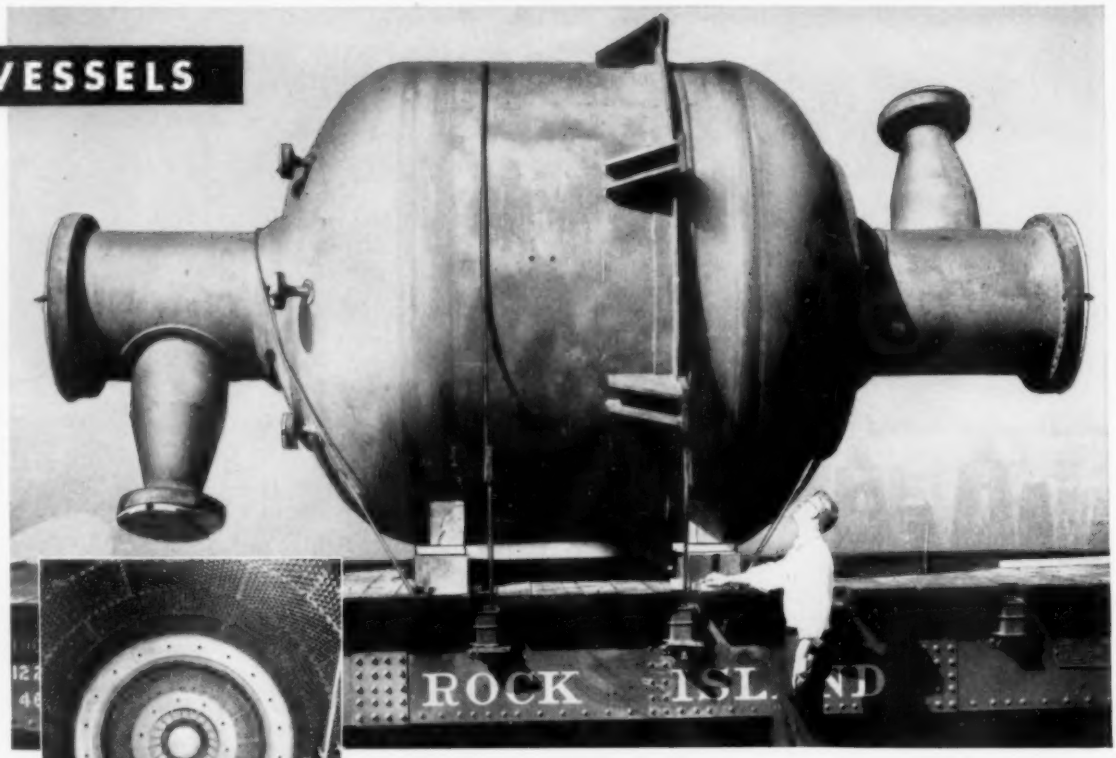
From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

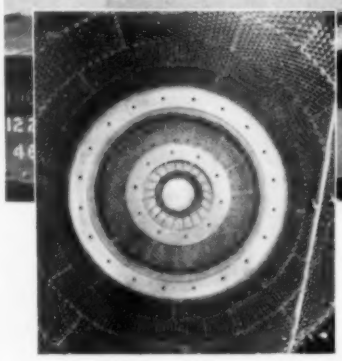
NIAGARA FALLS • TACOMA • MONTAGUE, MICH. • NEW YORK • CHICAGO • LOS ANGELES

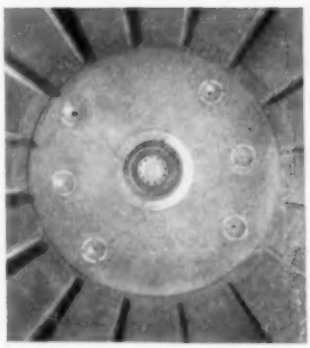
A.O.Smith for

VESSELS



Refractory-lined reactor ready for shipment from the Milwaukee plant. Overall length, flange-face to flange-face: 21 ft. 7 in. Three of these A. O. Smith reactors, when installed, become the heart of a catalytic reforming plant.





These interior views show, *at top:* expanded metal liner support prior to gunniting insulation. Grid platform support rings are visible. *Lower picture* shows shop-installed refractory lining covered by stainless steel lining designed with interlocking expansion joints.

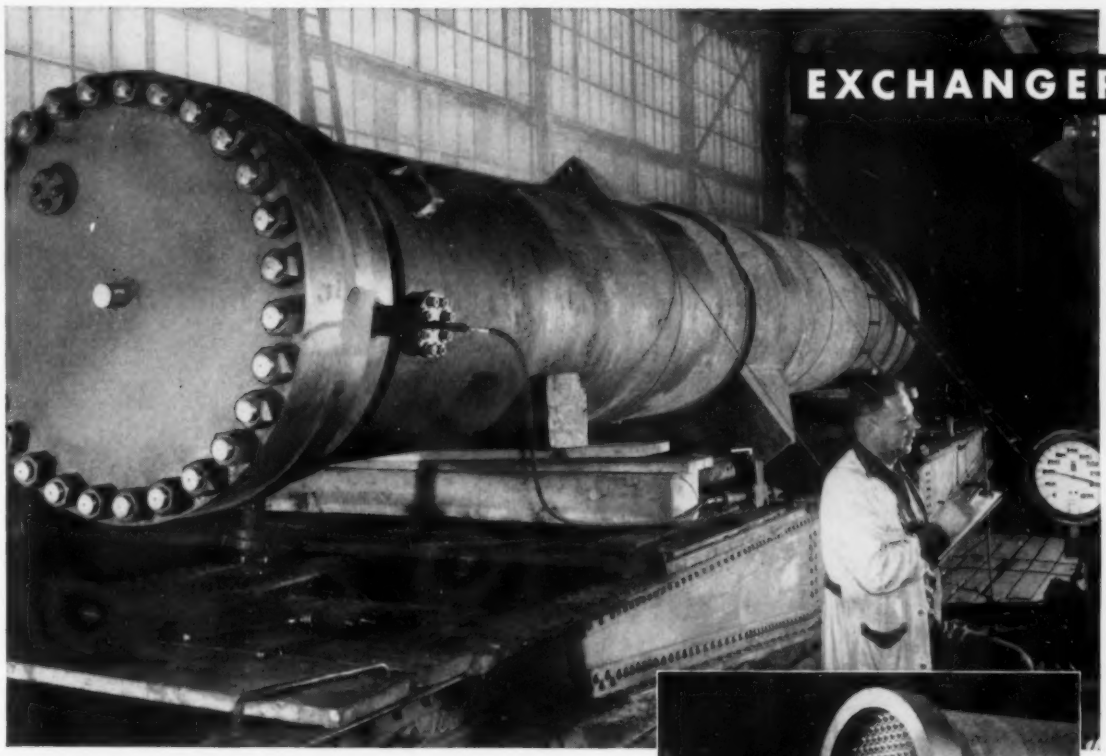
HIGH TEMPERATURE

A. O. Smith lined and

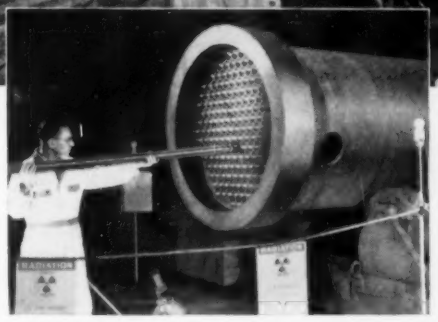
For thirty years, petroleum and chemical industries have come to us with pressure vessel and heat exchanger problems. Their reliance on the unmatched advantages we offer in manufacturing know-how and the resourcefulness of our research laboratories and technicians, design engineers and shop men has proved to be well placed. The two reactors shown here are examples of our work.

On this page is a special, refractory-lined vessel of A-212 steel, designed for 650 psi. and temperatures starting at 900° F. The walls are protected by shop-installed refractory lining. Total weight of 50 tons includes 28,000 lb. of lining, its supports

Outstanding Advantages



Shown here is one of twenty poly reactors going through our heat exchanger shop, undergoing tube side pressure test at 2160 psi. One-quarter inch wall tubes are welded to tube sheets and tubes rolled full depth on all poly reactors.



Radioactive cobalt being used for examination of welds during poly reactor construction. This method permits examining welds that are inaccessible to X-ray equipment.

HIGH PRESSURE
tubular reactors

and a catalyst grid platform on pedestal rings.

On this page is shown a poly reactor undergoing shop tests before shipment. Throughout fabrication and long before shop work begins, materials and processes are subjected to exhaustive tests to make sure quality demands are met. Metallurgical, spectrographic and pressure tests during and at completion of construction assure conformity to specifications.

YOU ARE INVITED

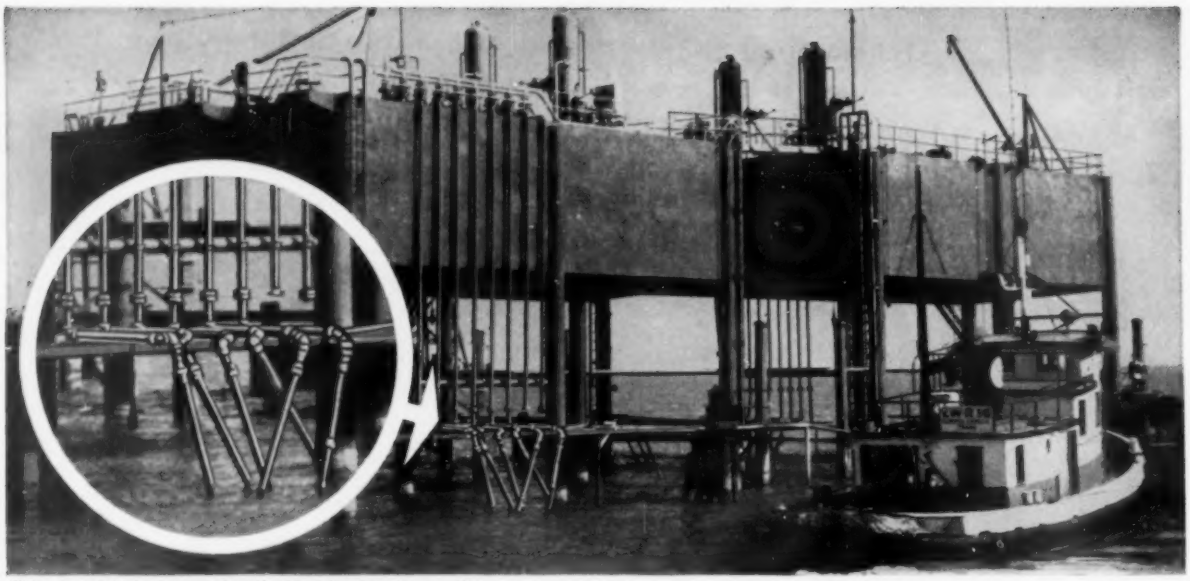
Whenever you have a pressure vessel or exchanger problem, write our Milwaukee office for information about the outstanding advantages which A. O. Smith research, engineering and construction offer.

Through research A.O. Smith *... a better way*

A.O.Smith
CORPORATION

Process Equipment Division
International Division: Milwaukee 1
MILWAUKEE • HOUSTON • LOS ANGELES

For glass-lined process equipment, contact GLASCOTE PRODUCTS, INC., Cleveland 17, Ohio—A new A. O. Smith Subsidiary



Chiksan swivel joints are used on the 12 underwater lines on this portable submersible tank battery barge which stores oil from 12 wells. Three swivel joints are used on each line to provide necessary flexibility and safety against storms, wind and waves. Visible in this photograph are style 50 Chiksan joints. Style 10 and style 50 joints are below the surface.

Davey Jones' Locker

Each submersible tank battery has a 6" or 8" CHIKSAN aluminum Marine and Barge Loading Hose that permits unloading of oil to the barges.

After 3 years of under-water service this CHIKSAN Marine Swivel Joint has been raised from 14 feet of water 13 miles from shore to service the packing.

Same CHIKSAN joint being cleaned of marine growth after re-packing and preparatory to re-submerging for years more of safe and economical service.

IS FULL OF *CHIKSAN* MARINE SWIVEL JOINTS . . . 3 Years of Storms, Wind and Waves Have Proved the Flexibility, Economy and Safety of CHIKSAN Marine Swivel Joints in Submerged Salt Water Service.

In the bays along the Texas and Louisiana Gulf Coast submersible tank-battery barge storage and transfer of oil has been made both possible and practicable with the application of CHIKSAN Marine Swivel Joints to the under-water flow lines.

In waters that range from 8 to 35 feet deep and with pressures up to 2100 psi. CHIKSAN joints have given the necessary flexibility of flow lines, economy of transport and safety of operation in transferring oil for distances in excess of 13 miles under water without line rupture or loss of product. Tight bends and connections on the flow lines between well platforms, tank batteries, metering platforms or drilling structures in the operation of off-shore locations that could not withstand the "Sunday Punch" of wind, waves and dragging boat anchors, are eliminated by the use of CHIKSAN swivel joints.

CHIKSAN'S special design submersible Marine Swivel Joints have once again solved a costly and perplexing problem of the Petroleum Industry.

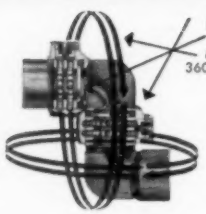
Write CHIKSAN Engineering and Research for complete details. Dept. 5-PP

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

THE NEW TOOL OF MODERN INDUSTRY



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles, and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 70° to a plus 500° F. with packing materials for each specific service.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

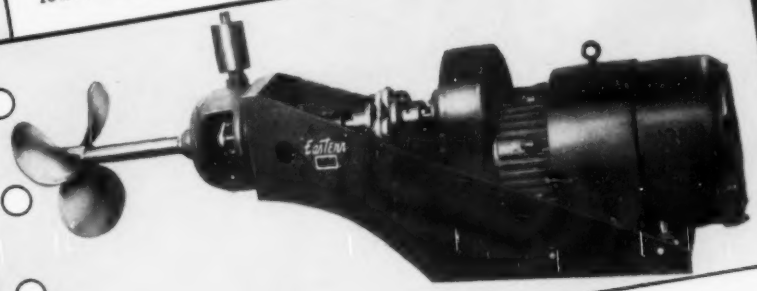
Weil Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif.; Newark 2, N. J. • Chiksan of Canada Ltd., Edmonton, Alta.

(To obtain more data on advertised products see page 776)

..EQUIPMENT NOTES

TOP ENTERING MIXERS

Eastern Series C Vertical Mixers are applicable to a wide variety of specialized needs. They're designed for tanks needing agitators with a range of 1/4 to 10 H.P. at standard speeds of 1725, 1140, 420 and 280 R.P.M. They have standard NEMA ball-bearing type motor with a rigid-type coupling between motor shaft and propeller shaft. Stuffing box is separate component and can be made of any alloy, allowing lower original cost.



HEAVY-DUTY SIDE ENTERING MIXERS

Eastern Series A Mixers are extra heavy-duty machines for large tank capacity. They range from 5—30 H.P. at standard speeds of 1150, 420, and 280 R.P.M. Shaft is coupled to standard motor by flexible coupling, and the shaft and bearing housing move as single unit to allow easy adjustment and repair. Stuffing box is repackable with full tank.

Eastern

Catalog sent on request . . .

The complete Eastern catalog of Fixed Mounting Mixers, both Top and Side Entering, is yours on request. Ask for Bulletin 610—A.

EASTERN INDUSTRIES, INC.

• • • NORWALK, CONN. • • •

CONOMOTOR *Series* LB CONTROL VALVES

THESE LEADING COMPANIES have *MODERNIZED* with CONOMOTOR *Series* LB CONTROL VALVES

Progress cannot be denied! Naugatuck Chemical Division of U. S. Rubber Company has completely equipped a new plant with Conomotor Series LB Control Valves for temperature control on reactors. U. S. Steel is using a large quantity of these valves for various services in their new coal chemical facilities in the midwest. E. I. du Pont use Conomotor Control Valves for their complete valve equipment in a new pilot plant at their Eastern Regional Laboratories. Armstrong Cork Co. has standardized on Conomotor LB Valves for an extensive modernization program. These important decisions were based on thorough evaluation of design, performance and cost. When companies of this caliber approve and adopt a new advance in process control, you can rely on their judgment. These and other new installations are typical of the important part Conoflow final control elements play in the modern industrial evolution to automatic control. Whether you have a new plant or plan to modernize your old plant it will pay you to talk to Conoflow.

- Armstrong Cork Co.
- Bakelite Company
- Colgate-Palmolive Co.
- Curtiss-Wright Corp.
- E. I. du Pont de Nemours & Co., Inc.
- Emery Industries, Inc.
- General Electric Co.
- Heyden Chemical Corp.
- Naugatuck Chemical Division U. S. Rubber Co.
- Philadelphia Electric Co.
- Publicker Industries, Inc.
- Jos. Schlitz Brewing Co.
- Sharples Corp.
- The Sherwin-Williams Co.
- U. S. Steel Corp.
- Victor Chemical Works
- Westinghouse Electric Corp.

WRITE FOR CATALOG LB-1. "PORTENT OF THINGS TO COME"

CC-400

Cono-Controls®

CONOFLOW CORPORATION

FOREMOST MANUFACTURERS OF FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

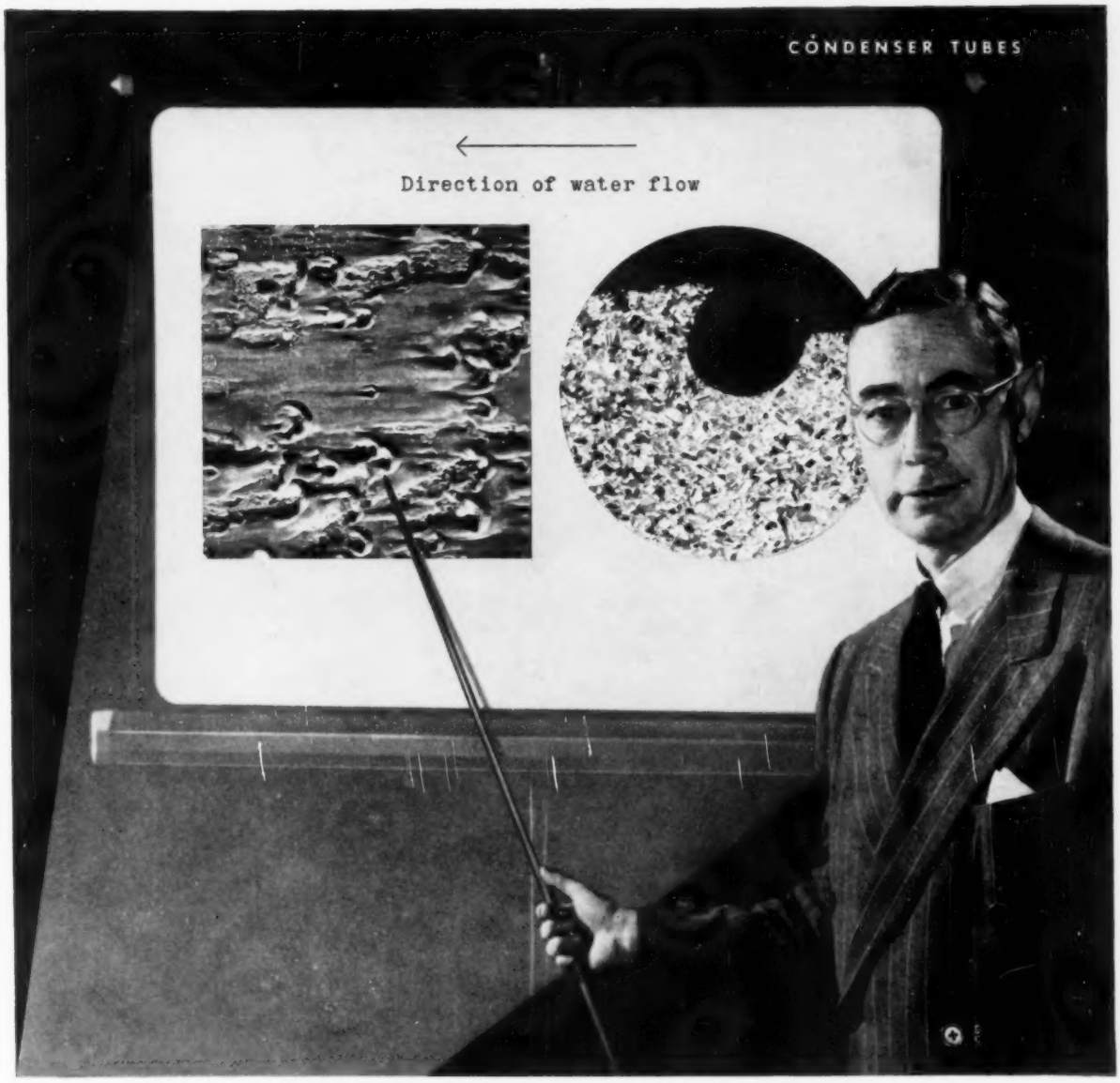


Illustration at left shows impingement corrosion of an Admiralty tube by high velocity sea water containing air bubbles. At right, longitudinal section through part of horseshoe-shaped pit is shown.

AIR BUBBLES: what causes them, how they affect condenser tubes

Before corrosion can occur, oxygen from the air dissolved in cooling waters must be present. But normally its presence doesn't cause *rapid* corrosion of condenser tubes.

What can cause rapid corrosion is air in the form of bubbles where turbulent flow is present. Whirlpools in the intake tunnel, leaky packing glands on pumps and at projections in injection pipes or water boxes may produce air bubbles of harmful size. Any condition that will produce a negative pressure at some point along a tube, such as a long outlet leg from a condenser, can cause air bubbles. Local pitting may then occur rapidly.

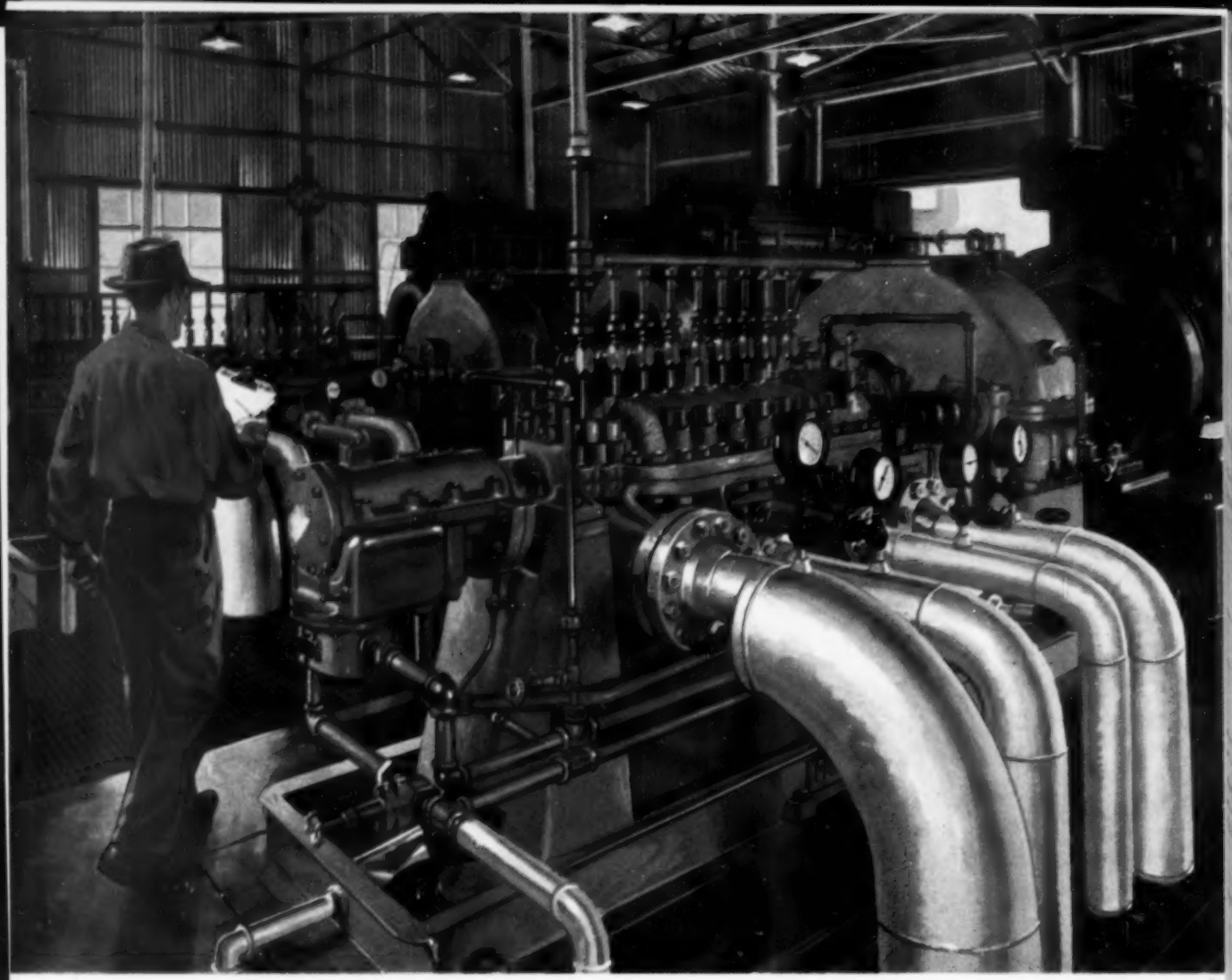
Air bubbles are only one factor affecting tube life. Publication B-2, "Anaconda Tubes and Plates for Condensers and Heat Exchangers," discusses *all* the important operational factors, and gives much other useful information. And, of course, our Technical Department stands ready to assist you in the selection of tube alloys from our extensive line. *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

5410S

ANACONDA®

Tubes and Plates for Condensers and Heat Exchangers

Arsenical Admiralty-439; Ambraloy-927; Cupro Nickel, 30%-702; and other copper alloys.*
*U. S. Patent No. 2,003,685 (Orig.)



Pacific Pumps inc.

IS ONE OF THE DRESSER INDUSTRIES

Pacific Pumps Inc., of Huntington Park, California, has grown from a small group of six men in 1923 to one of the leading manufacturers of custom-built centrifugal and steam-turbo pumps in the United States. Pacific also licenses several manufacturers abroad. Superiority of design, engineering, quality and workmanship has elevated Pacific Pumps to a position of pre-eminence and leadership in the international petroleum and processing industries.

MAGNET COVE BARIUM CORP., Houston, Tex., Malvern, Ark. Magcobar drilling mud, Magcogel bentonite, Mylojel, Fiber Seal, Jel-Oil mud.

CLARK BROS. CO. DIVISION, Olean, New York. Engines and compressors—gas, steam and diesel driven.

DRESSER MANUFACTURING DIVISION, Bradford, Pa. Oil and gas pipe couplings, fittings and sleeves—rolled and welded rings—welded fittings and flanges.

KOBE, INC., DIVISION, Huntington Park, Calif. Complete hydraulic oil field pumping systems, including the Kobe Free Pump.

What is the DRESSER plus+?

The Dresser Plus is the extra *service* you get when you deal with any Dresser company. It is an added advantage for you which stems from Dresser's unique overall organization. For Dresser is many companies with a single purpose—to provide the growing oil and gas industries with operating equipment that is *second to none.*

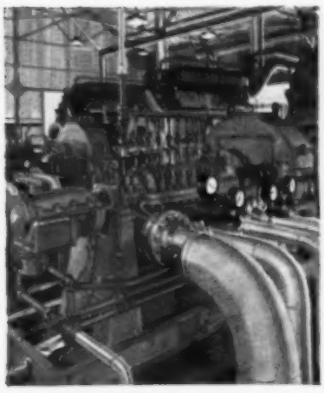
Each company in the Dresser group functions independently within its own specialized field—yet each can draw from the total resources, in manpower, research, and know-how, of the combined Dresser operations. When you work with any of the Dresser companies, all of the facilities of Dresser are *at your service.*

Planned, coordinated specialization—company by company—"one for all and all for one"—that is the DRESSER PLUS +

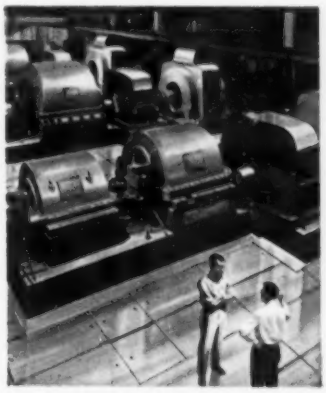
In the Utility, Industrial, Marine Service and other industries where steam generating is required, Pacific Custom-built Boiler Feed Centrifugal Pumps have long been accepted as the criterion. Pacific Pumps Inc. also operates an independent division (within the organization) exclusively devoted to the manufacture and sale of superior oil well plunger pumps.

DRESSER INDUSTRIES, INC.
OIL, GAS AND CHEMICAL EQUIPMENT

ATLANTIC BUILDING ★ DALLAS, TEXAS



PACIFIC PUMPS, INC., Huntington Park, Calif. Centrifugal pumps, deep oilwell plunger pumps, hot oil and boiler feed pumps.

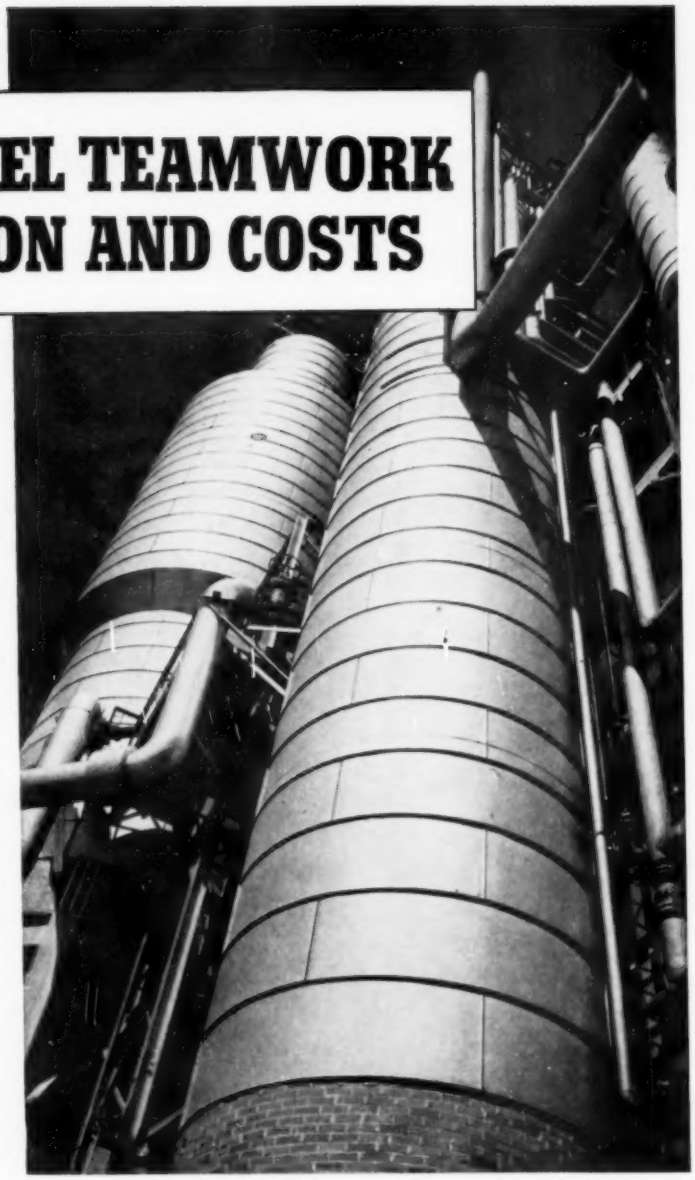


ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind. Rotary positive blowers, gas pumps, centrifugal blowers, exhausters; positive displacement meters.

SECURITY ENGINEERING DIVISION, Whittier, Calif., Dallas, Tex. Rock bits, reamers, casing scrapers, reamer rock bits, coring bits, Securaloy.

IDECO DIVISION, Dallas, Beaumont, Tex. Derricks, drawworks, rambler drilling rigs, traveling blocks, rotary tables.

HOW CLAD STEEL TEAMWORK CUTS CORROSION AND COSTS



Two clad steels combine specialized talents to lick corrosion in this 20,000-barrel-per-day refinery unit

Selecting material for this two-stage refinery unit was a double-tough problem. The upper section of the atmospheric tower had to withstand the corrosive action of condensing mineral acids and organic chlorides . . . the lower part had to handle corrosive asphalt crude containing up to 2.50% sulphur concentrations. The vacuum still had to process a lube cut at 750°F. The equipment builder solved the corrosion problem *economically* by teaming up two clad steels: Monel-clad for the upper part and stainless-clad for the lower part of the atmospheric tower, and stainless-clad throughout the vacuum still.

With economical clad steel—a layer of solid high alloy permanently bonded over its entire surface to a low-cost carbon-steel backing plate—there is no possibility of seepage or crevice corrosion . . . no costly maintenance or downtime . . . no equipment failure. In addition, clad steels assure resistance to thermal shock, flexible efficient operation, low first cost and easy economical field erection.

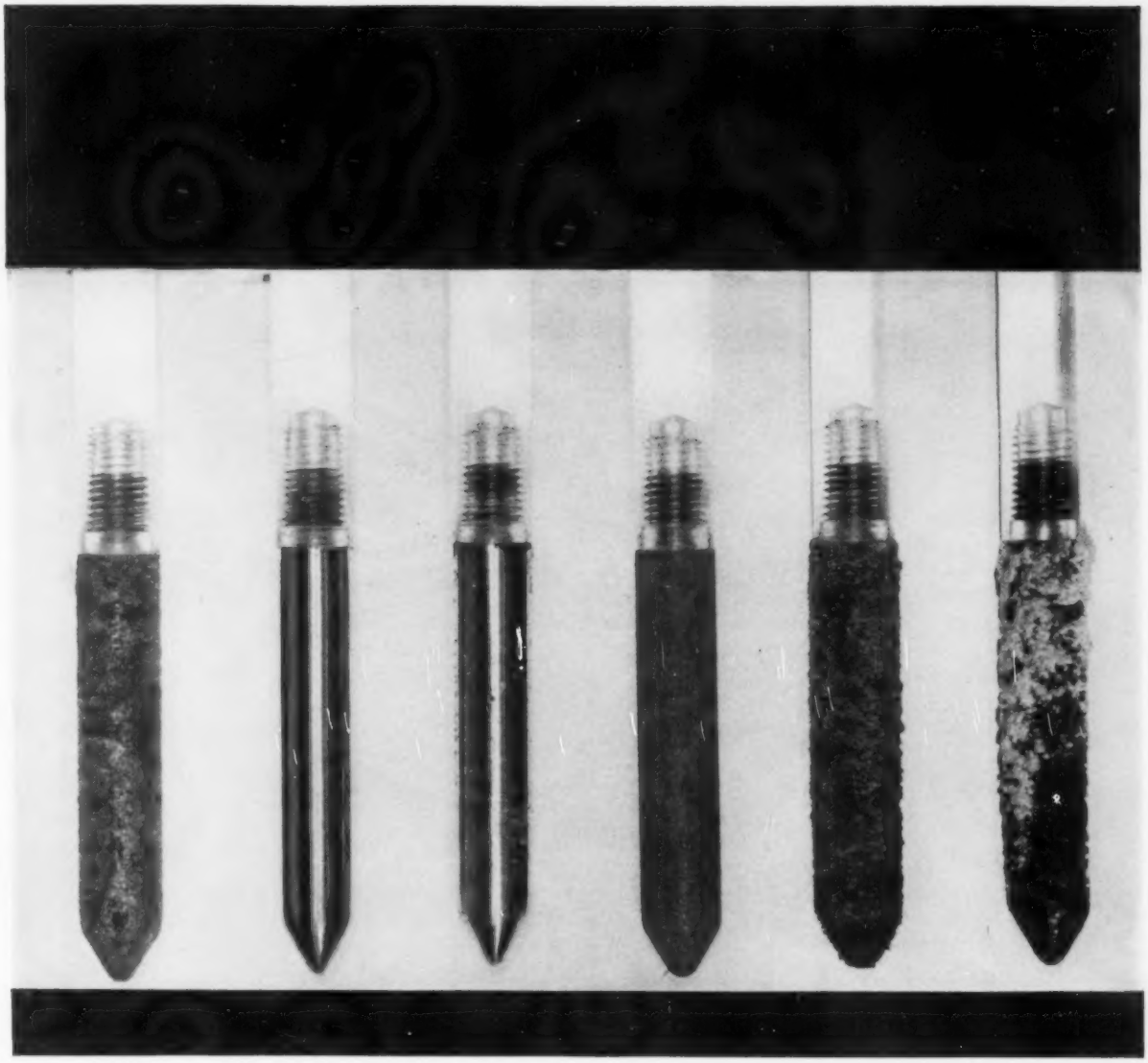
Equipment values like these also result from another kind of teamwork. Sound engineering and modern fabricating techniques can take advantage of the versatility of clad steels. You will find that it pays to consult your fabricators *early* in your planning for tanks and pressure vessels. They can work with your engineers and consultants, translate ideas into the specialized equipment you require.

Ask one of your fabricators to show you the new Lukens clad steel movie, "Equip for New Profits." Here—in full color and sound—are factual accounts of how clad steel equipment brings new economies. The story can suggest new ideas to everyone concerned with production efficiency. Or contact Manager, Marketing Service, Lukens Steel Company, 682 Lukens Building, Coatesville, Pennsylvania.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE



ONLY **UNICOR** PASSES RIGID ASTM TEST

The progressive refiner turns to Unicor to solve his corrosion problems. Here's why:

The test pieces shown above were submerged for 48 hours in a dynamic system of sea water and oil. In each case the oil contained a different, well-known corrosion inhibitor.

The test specimen exposed to the mixture inhibited with Unicor was the only one to remain as bright and unpitted as a freshly prepared, unexposed test piece. All of the other inhibitors permitted varying degrees of corrosive attack.

These results were obtained by using the procedure of ASTM D 665-53T — the generally accepted method for determining the corrosion-preventing characteristics of inhibited hydrocarbon oils.

The specific conditions involved exposure to the action of synthetic sea water, air and sour catalytic cycle stock at a temperature of 140° F. for 48 hours.

Similar results were obtained with gasoline and other distillates by using this and other types of tests, including the Navy Static Water Drop Test.

In the field as well as in the laboratory Unicor has proved to be the ideal, economical corrosion inhibitor.

Refiners everywhere are turning to Unicor as the best solution to their corrosion problems.

Let UOP Engineers design and service a UNICOR System to protect your refinery.

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UNIVERSAL OIL PRODUCTS COMPANY

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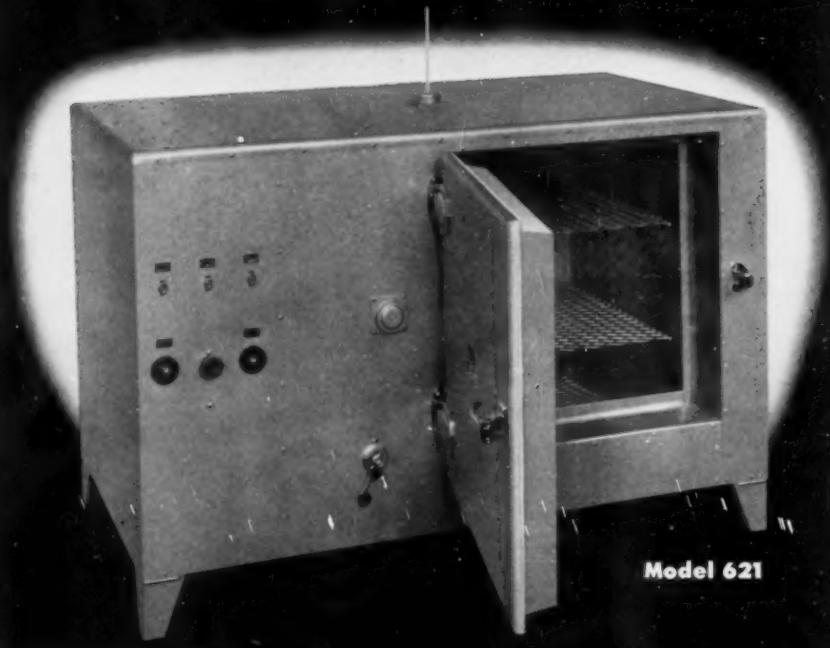
(To obtain more data on advertised products see page 776)

Now No Need to Wait or Substitute for FREAS OVENS



We have greatly increased our production over the last few months. Now we can **ship from stock** *many items that quality-conscious men like you waited months to get.* **Ask your laboratory supply dealer.**

Specify FREAS First ...to Last!

FREAS OVENS are built to serve 20 years or more, even in corrosive atmospheres. They are finer than ever.

Baked enamel *or* stainless steel exterior. Welded steel construction, thick glass wool insulation, stainless steel interior. Unconditional 5-year guarantee on ribbon element welded heater bank and dual safety hydraulic thermostat. Range to 260° C.

If your dealer doesn't have in stock the Freas Model of your choice, he can get these models promptly—601, 605, 625, 831, 120, 124, 40 and 50.

Precision Scientific Company

3737 West Cortland Street Chicago 47

Write for FREAS and THELCO Catalog No. 331

There is a difference in return bends—

Making a seamless return bend is no simple task. Holding it to the unvarying accuracy and metallurgical uniformity found in 180° WeldELLS® is a feat that could be accomplished only by the organization that pioneered the seamless return bend and perfected it through a quarter century of specialization.

Every WeldELL return bend gives you exactly what you ordered: true roundness, accurate size, full pipe thickness from end to end . . . controlled quality all the way through. No fitting tells the WeldELL story better than the return bend. There *IS* a difference!

And there *IS* a difference in *all* Taylor Forge Welding Fittings. It is a difference that is particularly important now that fittings made to low standards have come into the market. Today the best way to be sure you are getting welding fittings of highest quality, conforming to all codes and standards, is to specify Taylor Forge WeldELLS.

WeldELLS—the *first* complete line—is still the *most* complete line, in range of types, sizes, weights, materials. For up-to-the-minute facts see your Taylor Forge Distributor.

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TAYLOR FORGE & PIPE WORKS, General Offices and Works: P.O. Box 485, Chicago 90, Ill.

Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Gary, Ind.; Hamilton, Ont., Canada

 (To obtain more data on advertised products see page 776)

This MARLEY Cross-Flow has no secrets from the operator . . .

Open gravity distribution is one of the exclusive design features of Marley Cross-Flow cooling towers that makes them so "easy to live with" — and so economical to operate.

Is the water loading correct in every basin? Is the water flowing freely to every part of the tower fill? Are the basins clean? One glance and the operator of a Marley Cross-Flow has all the answers. And he takes that glance while making his inspection from a safe walkway. There is no need to subject himself to the hazards and discomfort of climbing into the tower to ascertain conditions.

If a change in water loading is desired, the valve is at hand and the variation in flow is visible. Since no pressure is required, increase or decrease in flow will not impair operating efficiency. No part of the fill will be starved; no part of the fill will be flooded.

Should a basin require cleaning, it is the work of minutes to shut down only the basin needing attention, clean it with complete safety and restore it to operation.

. . . a single glance tells you where you stand!

Open distribution and many other advantages of Marley Cross-Flow Cooling Towers are explained in Marley's new 32-page bulletin CF-54.

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. . . the special alloys that make good where other metals fail

HERE are some of the properties of Ampco Metal that help you keep production up, costs down:

- **Excellent resistance to corrosion in certain media.**
- **High tensile and compressive strength.**
- **Unusual resistance to wear from abrasion, erosion, and cavitation pitting.**
- **High physicals at extreme temperatures.**
- **High rate of heat transfer.**
- **High impact and fatigue values.**

Because it combines all of these qualities, Ampco Metal is often called The Metal Without an Equal.

No matter what you do — whether you work in the chemical or process industries, refine oil, run a steel mill, make stampings, generate power, or any of hundreds of other jobs, you can make Ampco Metal work for you. It saves operating headaches and production grief, because it often makes good where other metals fail.

These versatile special alloys fight wear, corrosion, impact, fatigue; give long life and dependable performance under the severest conditions. That's why they are widely used in such tough assignments as fractionating towers, exchanger components, slippers and screw-down nuts for blooming mill service, aircraft parts, dies, valves, bushings, and other punishing jobs.

Chances are Ampco Metal can help you, too. It's available in sand and centrifugal castings, sheets, plates, bars, tubes, extrusions, welding wire and electrodes. Consult your nearby Ampco field engineer or write us for full information.

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PR-16

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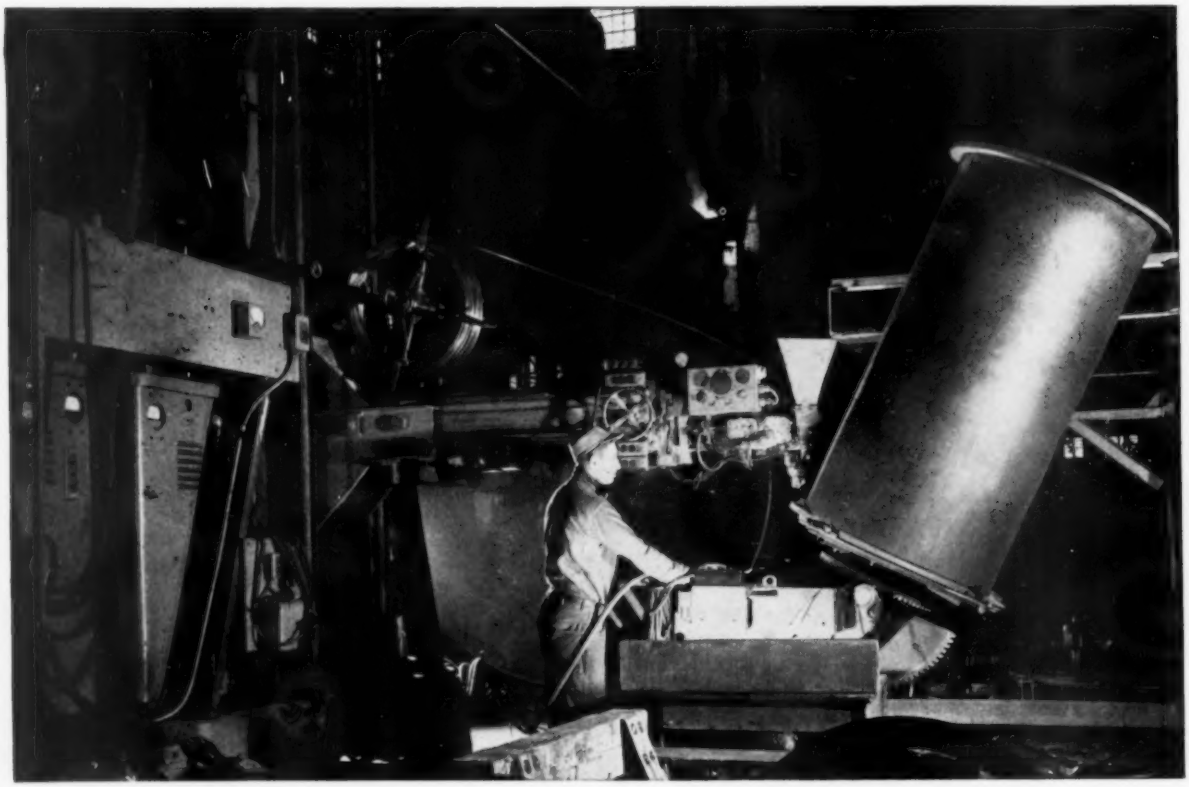
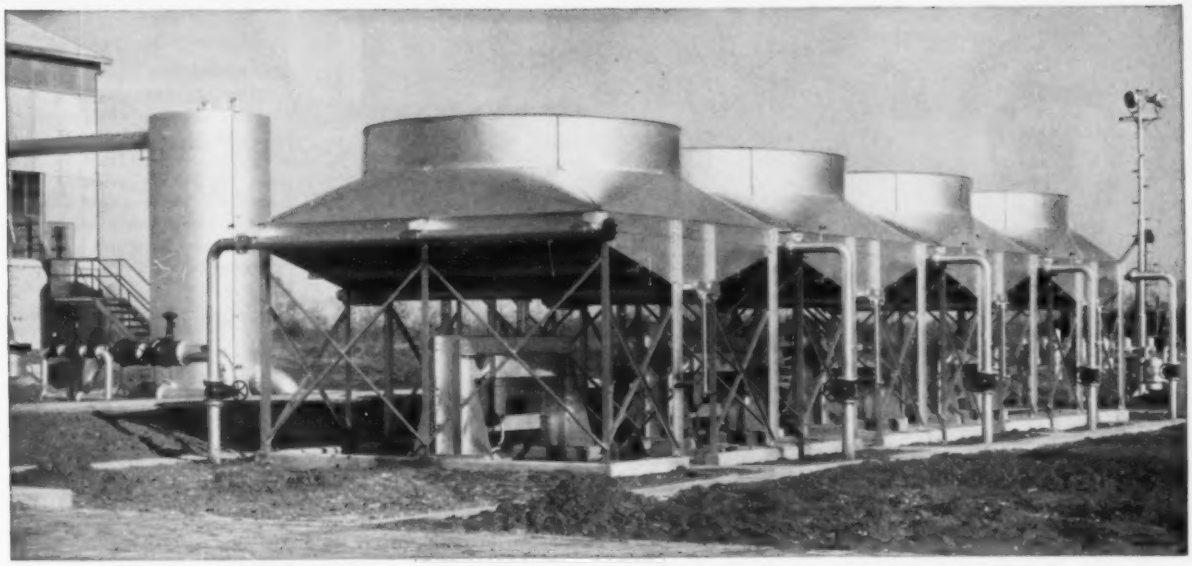
. . . examples of the wide variety of equipment designed and built by Alco to meet today's demands in petroleum and petrochemical processing . . . results of **Alco Experience** . . . gained through many years of designing and building equipment for refining and processing companies the world over . . . and **Alco Facilities** . . . capable of handling economically an extremely wide range of metal-fabricating operations . . . of meeting strictest customer requirements.

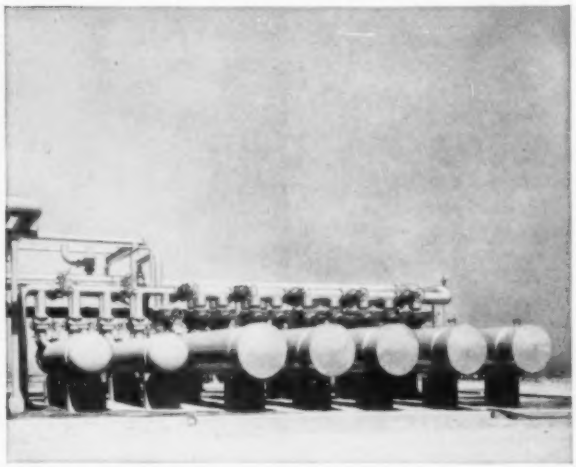


TOUGH FABRICATING JOBS are handled with ease in Alco's fully equipped shops, where virtually any type of equipment can be built at realistic low cost. Here a section of steel pipe, mounted on a universal-position pedestal, has flanges attached by submerged arc welding.

Processing problems



JACKET WATER COOLING for compressor engines on cross-country pipeline is efficiently performed by Alco Aircoolers even during summer's high ambient temperatures. Available in radiator-core and fin-tube types, Alco Aircoolers offer lower costs in scores of applications.



ALCO GAS COOLERS serve two absorption towers working in parallel at Lion Oil Company's Diamond M-Sharon Ridge gasoline plant near Snyder, Texas. Geared to produce 375,000 gal of petroleum products per day, Diamond M uses 39 Alco shell-and-tube heat exchangers of 21 separate types.

GRANGEMOUTH, SCOTLAND, is one of the world's oldest petroleum refining centers, with shale oil processing dating back over 100 years. At this historic site, Anglo-Iranian's refinery included 18 types of Alco heat-exchange equipment in its extensive expansion and modernization program.

How about your processing problems? Is heavy-duty service a factor? If so, contact your nearest Alco sales representative today —as the first step toward profit-building answers for you.

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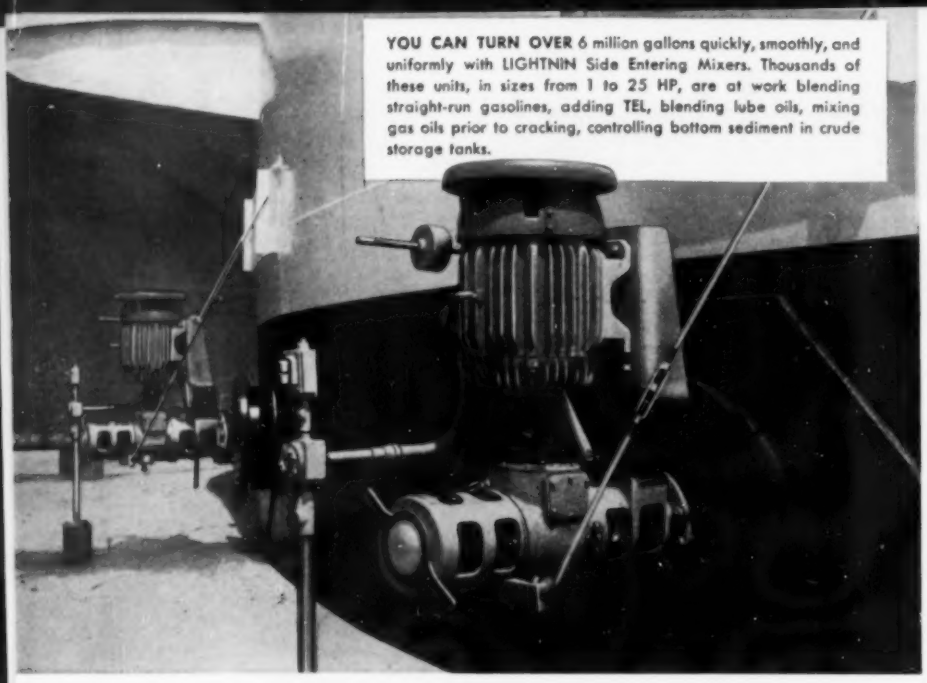


YOU CAN TURN OVER 6 million gallons quickly, smoothly, and uniformly with LIGHTNIN Side Entering Mixers. Thousands of these units, in sizes from 1 to 25 HP, are at work blending straight-run gasolines, adding TEL, blending lube oils, mixing gas oils prior to cracking, controlling bottom sediment in crude storage tanks.

How to be on safe ground when you plan for fluid mixing

A refinery engineer recently found he had been allowing two hours for a mixing operation that, when correctly done, took 15 minutes.

Why take chances with fluid mixing—when it's so easy to *be sure* you're right?

You can get the right data-answer for *any* fluid mixing problem—quickly, without cost or obligation—by handing the problem to your LIGHTNIN Mixer representative.

He eliminates guesswork and risk, by giving you an unqualified guarantee of *successful results.*

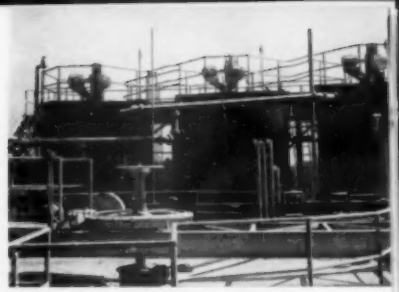
His approach to your problem is sound, fundamental—yet fully in step with today's processing methods.

His recommendations are based on 25 years of research and field experience on thousands and thousands of applications.

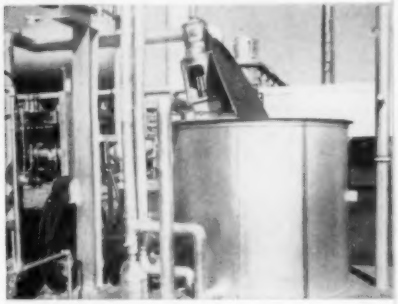
Save on upkeep, too

He can show you the way to maintenance savings you may never have thought possible with fluid mixers. A sensible program for reducing machine obsolescence, and keeping replacement costs low.

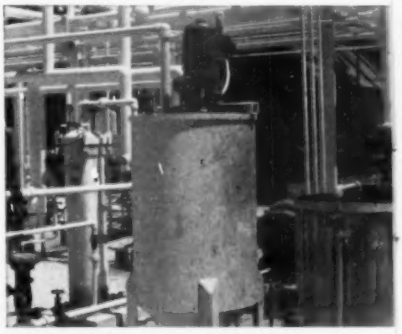
Before you select a fluid mixer for *any* purpose, find out how much time and effort you can save by checking first with MIXCO. Get the facts now on the LIGHTNIN guarantee that protects you unconditionally. Call in your LIGHTNIN representative—or write us today.



CAUSTIC TREATING and other mixing jobs become fast, efficient operation with turbine-type LIGHTNIN Mixers. You can mix, blend, suspend solids, get intimate gas-liquid and liquid-liquid contact, in open tanks or closed pressure vessels with these units. Standard sizes from 1 to 500 HP provide hundreds of power-speed combinations.



FOR TANKS up to 3,000 gals., continuous or batch mixing, pipeline mixing, there are 30 LIGHTNIN propeller-type models to choose from. Sizes ¼ to 3 HP.



OPEN TANK becomes an efficient mixing vessel when you add a LIGHTNIN Portable Mixer. Over 30 models, electric or air driven. Sizes ⅛ to 3 HP.

- ☐ DH-50 and DH-51 Laboratory Mixers
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air driven)
- ☐ B-502 Mud Mixers (oil well drilling)
- ☐ B-503 Mixers for BS&W Control

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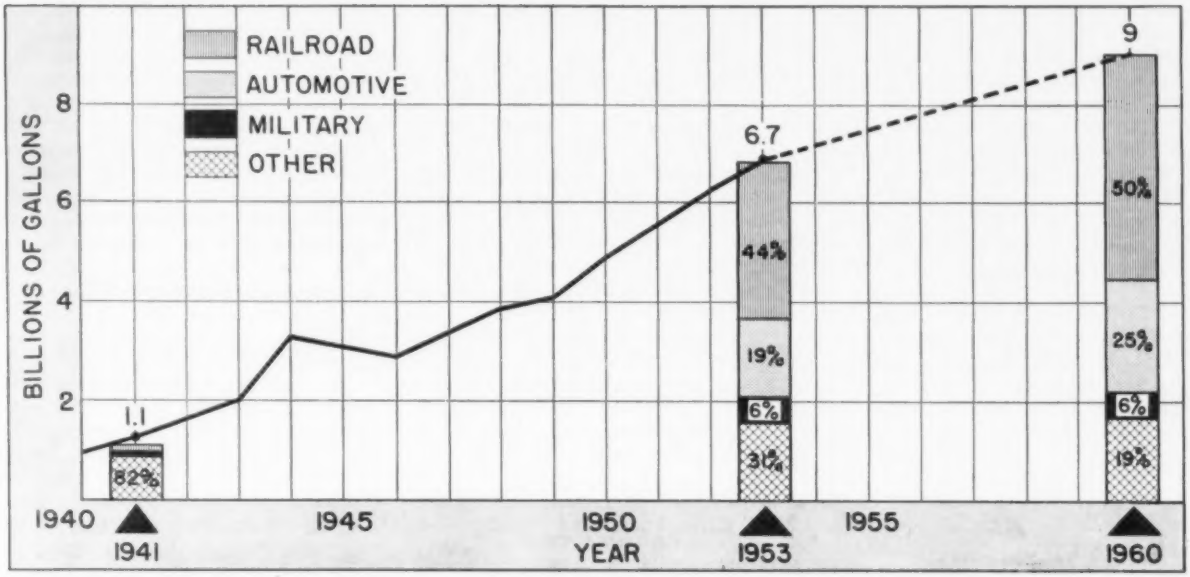


NINE TIMES UP is the growth pattern expected for Diesel fuel in the two-decade period ending in 1960. Chart above shows consumption by years since 1940, with breakdown by major uses for three years

Looking Ahead with Diesel Fuels

FOUR technologists—men who know the subject of Diesel fuels—got together in New York recently and held a panel discussion on "Diesel Fuels of the Future." They represented both suppliers and users, and their audience was composed of members of the Metropolitan Section of the Society of Automotive Engineers.

Here are the highlights of their forecast:

- **A 35% increase in demand** for Diesel fuels is expected by 1960—from 6.7 billion gallons in 1953 to about 9 billion gallons in 1960.
- **Railroad use of lower-quality** Diesel fuels is not likely on a general scale, although they will be used in spot locations providing the economics are satisfactory.
- **New types of lube oils** will promote the use of lower-quality Diesel fuels by compensating for some of their so-called ill effects.
- **Additives will be used more commonly** in Diesel fuels—particularly oxidation inhibitors, stability improvers, and cetane improvers.

THE GENERAL PICTURE

- **The demand for Diesel fuels,** according to William H. Hubner, petroleum technologist with the Ethyl Corp. and moderator of the panel discussion, is increasing faster than the demand for other major products from the petroleum barrel.

"Since 1941," he pointed out, "it has increased six-fold, compared to slightly less than a two-fold increase for 'all' petroleum products.

"In 1941, consumption of Diesel fuel was 1.1 billion gallons, as shown in the chart above, or only 4% of the gasoline market. By 1953, consumption had increased to 6.7 billion gallons, or 13% of the gasoline market. By 1960, the demand is expected to reach 9 billion gallons, or about

The Panel of Experts

Here are the four panel members who discussed the general subject of "Diesel Fuels of the Future" at a recent meeting of the SAE Metropolitan Section in New York City:

Moderator—William H. Hubner, Petroleum Technologist, Ethyl Corp., New York, N.Y.

Military—Harry F. King, Chief, Fuels and Lubricants Section, Materials Division, Bureau of Ships, Navy Department, Washington, D.C.

Railroad—W. King Simpson, Technical Director, Fuels and Lubricants, Electro-Motive Division, General Motors Corp., La Grange, Ill.

Automotive—Lawrence J. Grunder, Manager, Fuels and Lubricants Development Department, Richfield Oil Corp., Los Angeles.

14% of the expected gasoline market.

"Biggest single factor in this rapid growth has been the universal acceptance of Diesel-electric power by the railroads. In 1941, less than 1% of the freight service, 8% of the passenger traffic, and 5% of the switching service was handled by Diesel-electric locomotives, consuming 11% of the 1.1 billion gallons total. By 1953, Diesels were consuming 44% of the 6.7 billion gallon total and doing about 75% of the work on American railroads. Almost complete Dieselization is expected by 1960, at which time the railroads should account for about 50% of the expected 9 billion gallon total.

"Civilian automotive equipment (such as trucks, buses, tractors and bulldozers) consumed less than 1% of the total Diesel fuel in 1941. By 1953, consumption had increased to 19% of the total. By 1960, a still further increase to about 25% is expected.

"Military Diesel-powered equipment has been consuming about 6% of the total Diesel fuel. Indications are that this percentage figure will remain substantially unchanged, unless we have another 'all-out' war, in which case it could approach the railroads' usage."

To meet this demand, refiners are finding it necessary to increase the "middle-of-the-barrel" yield, at the expense of residual yield.

"In 1941," Mr. Hubner continued, "the yield of middle distillate fuel per barrel of crude oil processed was 19%, as compared to 24% for residual fuel. By 1953, distillate yield had increased to 26% and residual yield was down to 17%, with the yield of gasoline remaining substantially unchanged. By 1960, the middle distillate yield is expected to be still further increased to about 29%, with a drop in residual yield to about 13% and a slight increase in gasoline yield to about 47%."

Trouble has been experienced, however, as a result of the increased demand coupled with the changing scheme of processing technology.

With the introduction of cracked distillates, it was necessary to pay closer attention to the problems of stability in storage and adequate ignition quality.

Storage Stability — Cracked distillates, unless they are subjected to adequate refinery treatment and/or fortified with suitable stability additives, generally tend to deteriorate more readily in storage than straight-run products. This deterioration results in discoloration of the fuel and in the formation of residues—both soluble and insoluble.

Discoloration is objectionable mainly from a sales point of view. Soluble residues, it is thought, are not generally harmful, although there is a belief that too high a soluble gum content might cause injector sticking. Insoluble residues, on the other hand, are likely to cause filter clogging, with resultant engine stoppage from fuel starvation.

"Closely related to the problem of instability is the phenomenon known as incompatibility, wherein two fuels which are stable by themselves become unstable in storage when blended. This behavior is believed to be due to the resultant lower solubility which precipitates out certain relatively insoluble materials.

"Two types of stability-compatibility additives have been developed, and a number of such additives are in commercial use today. One type consists simply of oil-soluble dispersing agents which control particle size of the insoluble residues, so as to permit them to pass through, rather than clog, the fuel filters. The second type combines dispersant properties with the ability to decrease the rate of formation of the insoluble residue."

Ignition Quality—Straight-run distillates have a cetane number in the range of 33 to 68, depending on the hydrocarbon composition. Paraffins rate the highest in cetane, aromatics the lowest. When compared with straight-run distillates from the same crude source, catalytically cracked distillates have cetane ratings from 5 to 15 numbers lower, and thermally cracked distillates have ratings from 15 to 25 numbers lower—the loss depending on the severity of cracking.

"Refiners with relatively high cetane number straight-run distillates," said Mr. Hubner, "have no difficulty in producing Navy 50 cetane number Diesel fuel which specifies a straight-run base. Such refiners are also able to blend a portion of cracked material and still meet the cetane requirements of automotive and railroad Diesel fuels, which generally permit the use of cracked products.

"On the other hand, cetane numbers become a problem to those refiners with relatively low cetane number straight-run distillates, to those refiners with a relatively large percentage of cracked products to blend into finished Diesel fuel, and to those refiners who prefer to transport, and to store at terminals, middle distillate fuel suitable for use either as heating oil or as Diesel fuel.

"Such refiners have several choices of solution. They can upgrade to the desired cetane level at the refinery by acid treating or solvent refining, by the use of cetane improver additives, or by a combination of refinery and additive treatment; or they can upgrade to the desired cetane rating at terminals, as required, through the use of additives."

The Ethyl Corp. has been working for many years in the field of Diesel fuel additives, and has developed a cetane improver designated DB-36 amyl nitrate. Details on the characteristics and performance of this material were contained in a recent paper presented at the annual meeting of the Western Petroleum Refiners Assn. in San Antonio. Excerpts from that paper appear in this issue, on p. 684.

RAILROAD DIESEL FUELS

The cost of operating a Diesel locomotive is mainly the cost of the Diesel fuel, which accounts for about 65% of the total. Therefore, the quality of that fuel becomes of prime importance.

Previous to 1944, according to W. King Simpson, technical director of fuels and lubricants for the Electro-Motive Division of General Motors Corp., and another member of the panel, the specification requirement for railroad Diesel fuel was 50+ cetane number and probably around 0.1% sulfur, although some railroads mentioned 0.5% sulfur. "During the war years," Mr. Simpson continued, "the railroads got down to lower quality fuels, here and there, and we had our first experience with fuels of this type. . . . From 1946 to the present, our own EMD fuel specification has called for a 45 cetane number, 0.75% sulfur product, but wherever a railroad had an opportunity to buy a fuel at a favorable price below these limits, we encouraged them to go ahead and find out what would happen."

Today, over 87% of the railroad Diesel fuel is of 45 or better cetane number. Table 1 shows the percentage of various qualities of Diesel fuel used by the railroads in four main geographical areas in the country.

Savings in fuel costs in locomotive operation, by virtue of using a lower quality Diesel fuel, Mr. Simpson pointed out, might not be all they appear to be. "Any saving in Diesel fuel cost might be nullified by some increase in the engine maintenance labor and material cost and might also result in a somewhat higher lubricating oil cost. Any economic study made by any railroad has to consider not only the decrease in the segment of Diesel fuel cost but also the possible increases in other directions."

Mr. Simpson then proceeded to describe a cooperative test program worked out by his company with various railroads for investigating the effect of various Diesel fuel properties under actual operating conditions. As a result of these tests, together with engine test stand work, the following findings were made:

Total Sulfur Content—"On the engine test stand we have evaluated some of the Wyoming-type straight-run fuels of 2% total sulfur. Those fuels were not so good. On the railroads, our Diesel locomotives have burned Montana fuels of 1.2% sulfur rather regularly."

Fuel Volatility — "The end point variations we have studied were not so unusual because we have not encountered fuels over 725° F. end point until recently. In the CRC full-scale field test work there was an attempt made to combine in the same fuel all of the lower quality limits of 1.0% sulfur, 700° F. end point, and 40 cetane number. We have some information from these tests which will eventually be available to everyone."

Pour Point—"Regarding the use of high pour point fuels, such fuels are excellent in every way except that they are difficult to handle. Some of the paraffinic-type fuels have pour points as high as 50° F. Since such fuels would not presently be too practical for railroad usage, we have been developing heating equipment and studying means of handling them."

Additives—"From the standpoint of Diesel fuel additives, we have had oxidation inhibitors and stability improvers brought to our attention through the years, and have conducted both short-time and long-time tests. We have come to recognize that such additives will be used when and where needed. On the ignition quality improver additive, DB-36 amyl nitrate, we have just completed two full-scale railroad field tests, and are in the process of measuring and rating the engine parts. A preliminary inspection indicates that the parts are practically in the same condition with or without amyl nitrate in the fuel."

Residual Fuel Blends—"There was quite a furor about emergency war time fuels wherein residual fuels would be blended with Diesel fuels to make a palatable product for our engines. We tested quite a few of these blends and found them unsatisfactory. However, these tests did lead us to an evaluation of a high-boiling distillate fuel. In other words, by vacuum distilling a higher boiling range product at the refinery we were able to obtain a true distillate fuel, even though its Engle distillation showed well over 800° F. end point. These types of fuels perhaps will have some utilization even though they also have the undesirable characteristic of high pour point."

Table 1—Cetane Number Range of Diesel Fuels Purchased by Class I U.S. Railroads—June 1952 to June 1953

(all figures are in terms of percent of total)

	REGION OF U.S.				TOTAL
	Eastern	Southern	West & SW	Far West	All Regions
Below 40 Cetane	0.0	0.0	0.1	0.0	0.1
40-45 Cetane	1.6	0.4	3.0	7.6	12.6
45-50 Cetane	20.1	10.0	3.9	5.8	39.8
Above 50 Cetane	10.3	9.1	26.7	1.4	47.5
Total, each region	32.0	19.5	33.7	14.8	100.0

Source: *Railway Purchases and Stores*, July 1953, pg. 142.

Mr. Simpson then drew some conclusions to predict the railroad Diesel fuels of the future:

1—Railroads probably will continue to use good quality fuels whenever and wherever possible. They will do so because they know their equipment performs satisfactorily on such fuels and they do not want to jeopardize the future by changing to lower quality fuels. "I think this is a very strong influence on many railroads. Certainly it is one that will retard the wholesale movement to degraded type fuels, even if it were possible."

2—Some railroads will use degraded fuels in certain locations. These fuels are not universally available, but will be used where available if the economics are satisfactory.

3—There will be new type lubricating oils to compensate for some of the so-called ill effects of low quality fuels. "We have already seen this trend. In fact, certain improvements in lubricating oils have benefited our engine even on good quality fuels, and there is a greater margin for improvement when the fuel is degraded."

4—Additives will be used more commonly in Diesel fuels. "Oxidation inhibitors and stability improvers are already with us, and I am sure other additives will come along. The work we have done up to now indicates that additives will probably not be the potential problem that seemed possible a few years ago."

5—More of the middle distillates, because of the railroad's increasing demands, will be burned in the future as Diesel fuels and less as heating oils.

AUTOMOTIVE DIESEL FUELS

Automotive Diesel fuels was the topic of a third member of the panel —Lawrence J. Grunder, manager of the fuels and lubricants development department for Richfield Oil Corp.

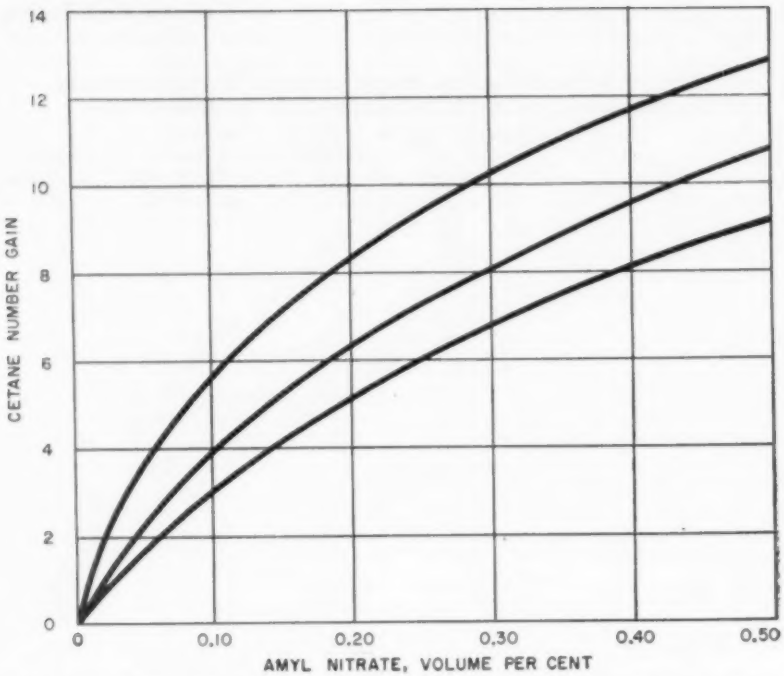
"There will be a continued trend toward converting the heavy residual fuel into lighter and more valuable distillate type fuels," he predicted. "Since straight-run Diesel fuel fractions are also desirable as raw charging stocks for cracking and reforming processes to make profitable higher-octane gasoline, it is only logical that chemical arrangements of new kinds, not yet available for evaluation, will be created.

"In the time required by the petroleum industry to justify the need for this higher-octane number automobile fuel production, the automotive industry will be moving further toward the presently conceived limit of spark-ignition engine compression pressures, and will approach the lower pressure limit of the compression-ignition or Diesel engine. It is in this area of engine development that the chemical nature of combustion must be examined carefully because, by that time, the major moves for the next half-century of internal combustion power production will have begun to crystallize."

MILITARY DIESEL FUELS

Fourth member of the panel was Harry F. King, chief of the fuels and lubricants section, materials division, Bureau of Ships, U. S. Navy Department.

His remarks were not cleared for publication, except that he did point out that, "forecasting the shadow of things to come," there would shortly be only one military specification for Diesel fuel—MIL-F-16884b, covering Navy Diesel fuel. All other military requirements, he said, would be procured under a new Federal specification, which is now being circulated among users and suppliers. This proposed new specification calls for four grades—Arctic, Winter, Regular and Heavy, and incorporates two changes worth noting: 1) the cetane number of the Arctic grade will be raised from 35 to 40, and 2) cetane number requirements can be attained by the use of an additive such as amyl nitrate.



MORE CETANE NUMBERS for Diesel fuels can be secured by the use of amyl nitrate

What Amyl Nitrate Does To Improve Diesel Fuels

Much has been heard during the past few years about the use of amyl nitrate as an additive to improve the ignition qualities of Diesel fuels — but little has been published on its actual effect. Below are presented the first extensive data made available on the subject. They are the principal portions of the paper "The Development and Utilization of Amyl Nitrate as an Ignition Improver for Diesel Fuels" presented at the annual meeting of the Western Petroleum Refiners Assn. in San Antonio, Texas, March 29-31, by

E. A. DESMOND and G. C. WILSON
Ethyl Corp., Detroit, Mich.

ONE outstanding characteristic of catalytically-cracked middle distillates when used as Diesel fuels is that they are generally lower in ignition quality or cetane number than the straightrun middle distillates obtained from the same crude source.

It appeared from surveys made that the availability of a Diesel ignition improver would be most desirable to assist refiners in meeting cetane number requirements. An Ethyl investigation of over 300 compounds thought to have possibilities as cetane improvers disclosed that primary amyl nitrate was the best additive of all these from several standpoints, including cost-effectiveness.

The cetane response to amyl nitrate of 20 representative Diesel fuels of different types is shown in the chart above. One of the significant characteristics of the compound is the high boost obtained with the first small percentages added to the fuels.

It was well known, of course, that secondary amyl nitrate previously had been investigated to some extent as a cetane improver. Two immediate advantages of the primary compound over the secondary are the greater effectiveness at low concentrations and the increased stability both neat and when blended with a fuel.

During the program of testing primary amyl nitrate the compound was designated by the laboratory number DB-36. This designation has also been used during the first year of marketing this compound but the commercial name is now being changed to "Ethyl" Diesel Ignition Improver. For the sake of brevity, the laboratory designation DB-36 or amyl nitrate will be used in referring to much of the test work on this compound.

Storage Stability: It has been recognized that there is the possibility that the addition of any chemical, such as DB-36, might alter the tendency toward forming undesirable elements in the Diesel fuel during storage. A test program was set up at the Ethyl Laboratories to investigate that possibility. (Omitted here is a portion of the original paper describing the test and giving examples of typical results.—Ed.)

The results may be summarized as follows:

1. The addition of DB-36 has no effect on the formation of insoluble gums in distillate fuels in normal storage conditions.

2. Commercial stabilizers are available which will effectively prevent the formation of insoluble gums in unstable fuels whether or not DB-36 is present.

3. The "Steam-Jet Gum" figure may be increased to an extent in some fuels by the addition of DB-36. It should also be pointed out that the additive will distort the results of other types of tests, which are accelerated by high temperatures or actinic reactions, such as those used for quick evaluations of stability characteristics of fuels.

Effect on Combustion: After investigating the effects of amyl nitrate on fuels, the next step was to determine what the reaction of engines to these additive cetane numbers was and to compare it with the reaction to natural cetane numbers.

The ignition-quality requirement of a Diesel engine is established by the most severe conditions under which the engine must operate. These conditions occur whenever the compression temperatures and pressures are low. It can be easily demonstrated that an engine which has been running under load can cool down sufficiently during a prolonged idling period so as to actually cease firing. Usually, such stoppage can be avoided by the use of a fuel of higher ignition quality.

The *ignition-delay period* for any given set of conditions is controlled by the ignition quality of the fuel. It is

the period of time between the start of fuel injection and the beginning of combustion. This delay period is used as a measure of the ignition quality of diesel fuels. Because of the minute interval of time for combustion in high-speed engines, misfire will result if this period extends beyond a few milliseconds. For example, an engine running at a speed of 1200 rpm. has a crank-angle speed of 7.2 degrees per millisecond, and an elapse of two or three milliseconds allows the piston to move beyond top center with a resulting decrease in the compressed-air temperature and pressure to a condition below that required to support initial combustion.

Even within the range of combustion conditions, the exact magnitude of this period is very important because, under normal conditions, the longer the delay period, the more rapid is the resultant combustion. The consequent rapid rate of pressure rise may approach that of a detonation. Such severe shock loading is undesirable both from the standpoint of noise and life of engine parts.

The ASTM cetane number is the recognized unit of ignition quality for Diesel fuels. It is determined in a special test engine by bracketing the unknown sample between two known samples of secondary reference fuels at a fixed ignition-delay period of 13 crankangle degrees (2.41 milliseconds). The secondary reference-fuel blends have known cetane ratings because they have been rated by the use of primary reference fuels. Thus, the percentage of the primary reference fuel, cetane, in the blend which would match the unknown sample is taken as the cetane number of that fuel.

For the laboratory studies of full-scale engine combustion, a strain-gage type of pressure indicator was installed in the combustion chamber of a commercial engine and pressure-time traces were obtained. The pressure-sensitive diaphragm of the indicator was mounted practically flush with the surface of the combustion chamber wall. Combustion diagrams were obtained by photographing the traces on the screen of a two-beam cathode-ray oscilloscope. The start and end of fuel injection were indicated on the oscilloscope through an electrical circuit connected to the fuel injector.

Fig. 1 shows a single pressure-time diagram for a two-cycle engine with a trace indicating the fuel injection and with a timing wave. The two delay periods indicated on this diagram are special points of interest. Usually the initial point of digression from the compression-pressure graph is taken

The Principal Properties of Amyl Nitrate

1—Toxicity

Tests have demonstrated that amyl nitrate offers no undue toxic hazards as a result of inhalation, contact with the skin or ingestion. Consequently, no special handling precautions need be followed in shipping or mixing. Experiments conducted on samples of exhaust gases, taken from a full-scale Diesel engine operating on fuels containing as much as 1.15% of amyl nitrate, have shown that this ignition improver does not contribute to odor, lachrymation or toxicity. There is no significant increase in the oxides of nitrogen present in Diesel exhaust gases resulting from amyl nitrate in the fuel.

2—Flammability

Amyl nitrate can be ignited in an open vessel from a flame and burns steadily at about the same rate as kerosine. A closed can of this material was placed in the center of a wood and paper bonfire. In a short time, the can ruptured and the liquid ignited and burned steadily in the fire. The tests show that it is combustible, but the fact that it has a flash point of 125° F. and does not burn rapidly or approach explosive violence classifies it as nonflammable under ICC regulations.

3—Volatility

The boiling point of amyl nitrate (305 to 314° F.) falls within the boiling range of the lighter constituents of average Diesel fuels. The flash point (125° F.) is high enough to have little effect on the flash point of finished Diesel fuel. In fact, 0.1% on the average lowers the flash point of a Diesel fuel by only 1° F.

4—Solubility in Diesel Fuel

Amyl nitrate requires no special equipment or complicated methods for blending into Diesel fuel. Experimental blends were made by simply pouring amyl nitrate from a can into a tank car and into two types of tank trucks at a refinery. The only precaution taken was to see that the bottoms of the tanks were covered with fuel before adding amyl nitrate. Analyses made on the series of samples taken from the tanks at the point of delivery showed completely uniform distribution of the amyl nitrate.

5—Solubility in Water

The solubility of only 0.028 parts of amyl nitrate in 100 parts of water at 68° F. is low enough to cause no problems in fuel systems where water is present. It has also been determined that emulsification of Diesel fuels is not increased.

6—Corrosiveness

Various kinds of metal, including steel, copper and aluminum, were submerged in amyl nitrate and stored in vented bottles in an ambient temperature of 110° F. for a period of several months. No corrosion was indicated.

7—Damage to Engine

An ASTM Cetane Rating Engine was operated for several hours on very high concentrations of amyl nitrate without any ill effects to the injection system or the engine.

8—Shock Sensitivity

Amyl nitrate has been thoroughly shock tested by dropping cans of this fluid from a height of about 25 ft onto a concrete platform. Rifle bullets have been shot through cans containing amyl nitrate and samples have been subjected to detonation by commercial blasting caps. There were no explosions under any of the conditions of test.

9—Stability

Amyl nitrate has been stored in tin cans and in steel drums for periods of over a year without any deterioration of the compound. Fuel containing amyl nitrate has been stored for three years in closed drums without loss of the additive or of the cetane-rating gain that it had when the blend was made. Fuel containing amyl nitrate has been stored underground for a period of six months without any loss in cetane rating.

10—Carbon Residue

Although the ASTM carbon-residue values of Diesel-fuel stocks are increased by the addition of this Diesel ignition improver, tests in full-scale Diesel engines have shown that engine deposits are not increased. Since the carbon-residue test is thus distorted by the presence of amyl nitrate, it should be made on the fuel prior to the addition of this ignition improver.

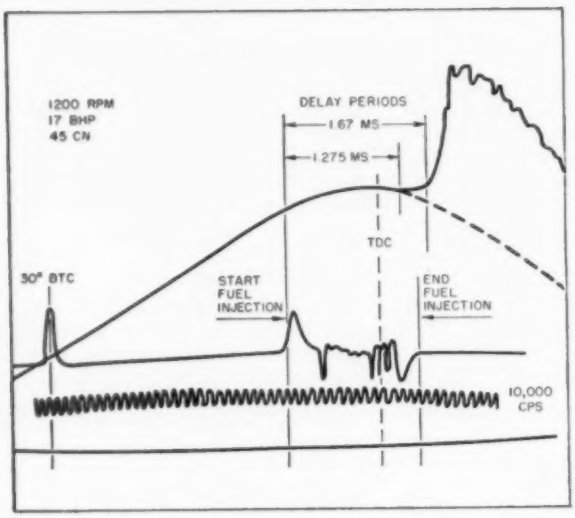


FIG. 1—Typical pressure-time diagram for low-load operation of a two-cycle Diesel engine

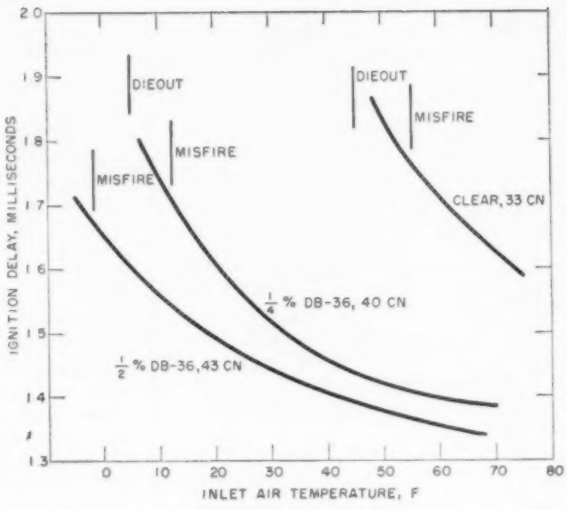
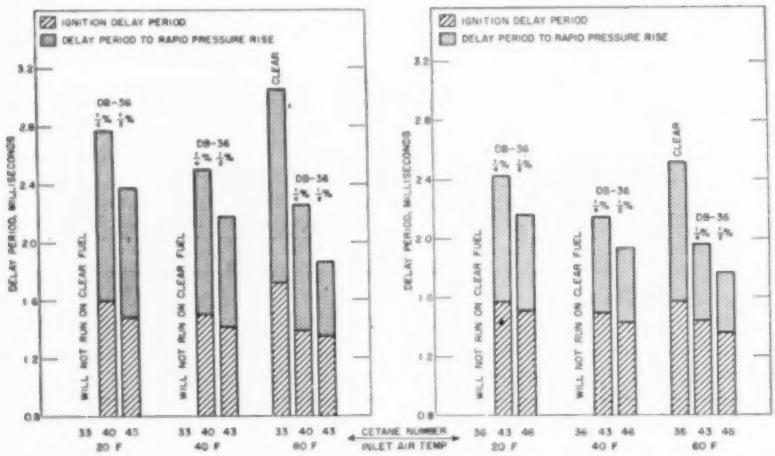
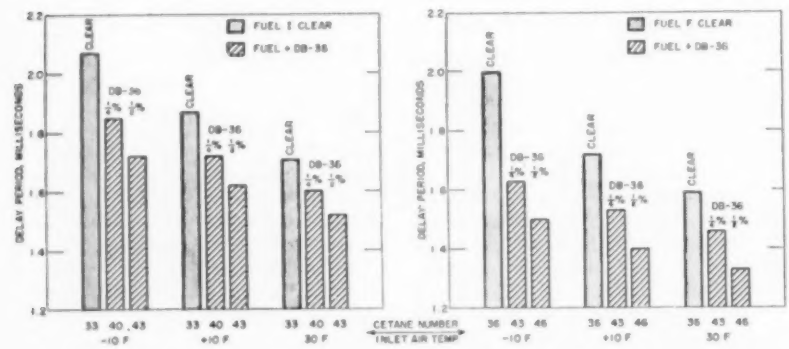


FIG. 2—Effect of amyl nitrate on fuel combustion characteristics in an open-chamber two-cycle engine (1200 rpm, 25% load, straightrun fuel I)



FIGS. 3 and 4—Effect of amyl nitrate on fuel combustion characteristics in an open-chamber two cycle engine, 1200 rpm, 25% load. Fig. 3 (left) shows straightrun fuel I, Fig. 4 shows catalytically cracked fuel F



FIGS. 5 and 6—Effect of amyl nitrate on fuel combustion characteristics in a prechamber four-cycle engine, 1000 rpm, 10% load. Fig. 5 (left) shows straightrun fuel I, Fig. 4 shows catalytically cracked fuel F

as the end of the ignition-delay period. However, under certain cool-engine operating conditions, combustion in this engine takes place in two stages, with a cool flame, which produces only a slight pressure rise, preceding the rapid combustion that causes a high rate of pressure rise. It is this point of the beginning of the rapid pressure rise that is the more significant. From similar diagrams data were obtained which are shown in the following graphs.

Fig. 2 shows ignition-delay data for an open-chamber, two-cycle engine. In an attempt to simulate warm-up conditions, the engine was operated at a low load, 17 bhp at 1200 rpm, with a 100° F. jacket cooling-water temperature. With intake air supplied from the cold room it was possible to vary the engine inlet-air temperature from 85° F. to —20° F. The base fuel, I, was a straightrun distillate from Coastal crude oil, with a distillation range of 352 to 644° F. While operating the engine on this 33-cetane number base stock, under the cool conditions as stated, misfiring began as the inlet air temperature reached 55° F. and dieout occurred at 45° F. The addition of ¼ % DB-36 to the fuel raised its cetane number to 40 and enabled the engine to operate under the same conditions with 12° F. inlet air temperature—a reduction of 33 degrees. These two curves indicate that, under these operating conditions, this engine will stall when the ignition-delay period becomes greater than about 1.9 milliseconds. The addition of ½ % DB-36 to the base stock increased its cetane

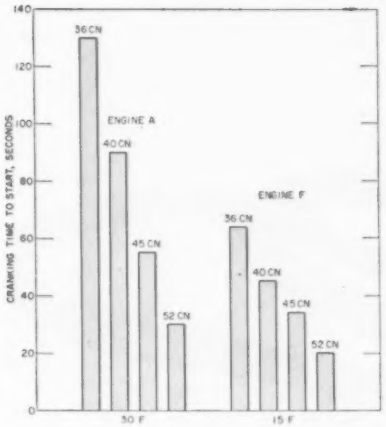


FIG. 7—Effect of cetane number of starting characteristics of straightrun fuels

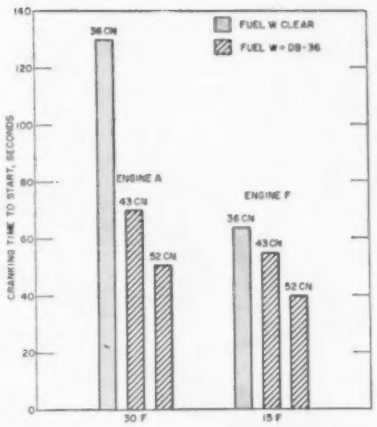


FIG. 8—Effect of amyl nitrate on starting of straightrun fuel W

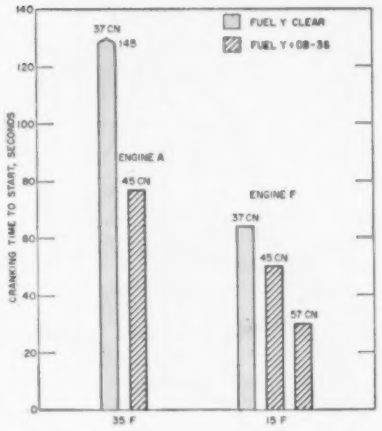


FIG. 9—Effect of amyl nitrate on starting of catalytically cracked fuel Y

number to 43 and enabled the engine to operate at still lower temperatures.

In Fig. 3, the bar graphs show a consistent reduction in the ignition-delay period for an open-chamber engine when DB-36 was added to a low cetane-number straightrun distillate. Note that the effect of DB-36 is more beneficial in reducing the delay period to the point of rapid combustion than it is in reducing the delay to the point of slow combustion. Since the rapid combustion must occur near top center to keep the engine running, the addition of DB-36 afforded satisfactory operation at considerably lower temperatures than were possible with the low-cetane fuel. The same series of tests were repeated using Fuel F, a California catalytically-cracked fuel of 36 cetane number. The bar graphs of Fig. 4 show that, in this engine, the addition of DB-36 to the cracked distillate was very effective in reducing the ignition delay.

In like manner the same two fuels were tested, with and without DB-36, in a prechamber type of four-cycle engine. This engine, which has a high compression ratio of 18:1, is considerably less sensitive to ignition quality than the open-chamber engine (compression ratio 16:1). However, Figs. 5 and 6 show a consistent reduction in ignition delay for both a straightrun and a catalytically-cracked distillate.

The results of these combustion studies show that, by means of adding DB-36, low-cetane stocks can be given ignition quality that is appreciated in these two types of full-scale engines.

Cold Starting: It is generally recognized that ignition quality is the fuel quality that has the greatest effect on the ease with which a Diesel engine may be started. A series of tests was conducted in the cold room with five different full-scale engines wherein the effects of both natural cetane number and amyl nitrate on cold starting were investigated in the critical temperature ranges with straightrun and catalytically-cracked fuels.

In order to simulate field conditions as closely as possible, all starting attempts were made after a minimum soaking time of 16 hrs at each test temperature with cranking speeds held to those obtained with cold batteries. Instrumentation was provided to determine the cranking time or the amount of starting aid required to start the engines under each condition, and also to check the time required for warm-up to the point of no misfire for one of the engines.

Both 36 and 52 cetane-number straightrun fuels and blends of these to make 40 and 45 cetane number were used for a reference framework in these tests. Amyl nitrate was added in two concentrations to the low cetane straightrun fuel and a matching cetane number catalytically-cracked fuel to check the effectiveness of the additive in reducing the difficulty of starting the engine.

Since there was a wide variation in the ease with which the different engines could be started on any given fuel, it was necessary in presenting the data to choose a particular temperature level for each engine to make a comparison of the fuels. The choice of a temperature was restricted in that the lower limit was fixed by the fact that the engine would not start on some of the fuels, and the upper limit was fixed by the fact that above a certain temperature the engine started readily on any of the fuels tested. A temperature within these limits was chosen in each case to represent a critical temperature insofar as comparison of a range of cetane number was concerned.

The cranking time required to start two of the engines with different cetane number blends of straightrun fuels is shown in Fig. 7. These engines represent the easiest and the most difficult to start of the engines not requiring starting aids below 30° F. The effect of amyl nitrate in the low-cetane number straightrun fuel is shown in Fig. 8. The effect of the additive in the catalytically-cracked fuel on the same two engines is illustrated in Fig. 9.

It may be seen from these charts that an increase in cetane number reduced the cranking time required to start in all cases. The effect of the numbers gained by the use of amyl nitrate was, in some cases, that which would be predicted from the ASTM centane rating and in others not so great. It was also obvious from the results of these tests that the ease with which the various engines started under moderately low temperature conditions varied widely.

Engine Cleanliness and Wear: (The paper also reported the results of a series of laboratory and field tests designed to determine the effect of amyl nitrate as a Diesel fuel additive on engine cleanliness and wear. The general conclusion of those tests was that amyl nitrate in Diesel fuels does not aggravate engine operating or maintenance problems—Ed.)

Utilization by Refiners: The results of all these tests may be summarized by stating that the practicality of the Diesel Ignition Improver has been amply proven in the laboratory and in the field. The availability of amyl nitrate as a Diesel ignition improver will permit a refiner to upgrade the ignition quality of available middle distillates that meet all the requirements of the engine operator except for the lack of adequate cetane number.

Let this panel of petroleum processing technologists, through the medium of a recorder, bring you . . .

TECHNICAL TIPS ON

Lining Process Vessels

THE exchange of information, ideas, and "know-how" can help solve almost any problem.

It was just such an exchange of practical experience and engineering knowledge that was presented last month in the article "Practical Tips on Catalytic Cracking Operations," and is being continued with the following series of questions and answers on vessel linings.

This information was developed last fall when over 200 refiners sat glued to their seats during an all-day session on various phases of plant operations. They heard answers to dozens of questions handled quickly and easily by a panel of nine technologists.

Broad experience, from small to large refiners, from two engineering firms, and from two raw materials suppliers, was represented by the nine-man panel. Moderator was E. A. Heike, chief engineer, Premier Petroleum Co., Ft. Worth, Texas.

The refining group consisted of: N. K. Anderson, director, research and development department, Deep Rock Oil Corp., Cushing, Okla.; W. M. Carney, refinery superintendent, Lion Oil Co., El Dorado, Ark.; A. D. Fischbeck, manager, Perco Division, Phillips Petroleum Co., Bartlesville, Okla.; and H. K. Wheeler, ass't. manager, technical department, Pan-Am Southern Corp., El Dorado, Ark.

The engineering group included: D. B. Ardern, Houdry Process Corp., Philadelphia, Penna.; C. O. Brown, American Cyanamid Co., Chicago, Ill.; Davis C. Read, Universal Oil Products Co., Des Plaines, Ill.; and E. C. Tinsley, Mexico Refractories Co., Mexico, Mo.

The session took place during a regional meeting of the Western Petroleum Refiners' Ass'n., at El Dorado, Ark., in October. The editors of PETROLEUM PROCESSING, through the medium of a recorder, are glad to be able to pass on to all segments of the petroleum processing industries most of the questions and answers the audience of 200 found so valuable.

The subject covered in this month's article is lining of process vessels.

Has it been necessary to line internally any catalytic cracking reactors to reduce wall temperatures, in order to avoid reactor failures due to excessive graphitization?

Read: As far as we are concerned, the answer is "No."

To Fischbeck: Yours isn't lined, is it, Dale, to reduce wall temperatures?

Fischbeck: No. By using 1% chrome, 0.5% molybdenum alloy reactor shells, the problem of internal lining to avoid graphitization is practically eliminated.

Ardern: None of the moving beds are lined.

Does anyone have monolithic-lined or alloy catalyst standpipes in service? If so, are they giving good service?

Anderson: I am certain that a number of Fluid units have alloy standpipes, just low alloy carbon steel. They are fine. We do not run into any abnormal erosion problems.

Wheeler: We agree with him. We have some inside-lined standpipes which are a pain in the neck when it comes time for a turnaround. The repairs to these standpipe linings have turned out to be bottleneck jobs many times. We definitely go along with the idea that a low chrome—maybe just 0.5% moly for temperature—will give very good service so far as standpipes are concerned.

We have effectively used lining for wear plates in some cases rather than for temperature protection. That has proven very effective. In other words,

this is not a true monolithic lining for temperature reduction on the metal, as we still went to alloy for the temperature. But hex steel supporting a refractory lining was used at different points in the line for wear protection.

Anderson: This is generally accepted practice with the original equipment. We never have had to make this particular choice. I'm happy that we did not because choices of that kind are difficult. It is pretty "rough" to put a dollar sign on the thing that Mr. Wheeler pointed out, occasionally repairing the lining in the line constituting a turnaround bottleneck. I have not been able to sell propositions like that too readily.

Read: The earlier war-time units, of course, had the lined standpipe; but, after the war we went to a low alloy standpipe, particularly in the regenerator standpipe, where the temperature was the principal reason for going to alloy, and thus got away from an internally lined standpipe.

Ardern: It has been brought out in a great many papers that replacing carbon steel standpipes with alloy steel apparently were economically justified on the basis of savings made in maintenance.

Has anyone used monolithic lining to replace refractories in Fluid catalytic cracker regenerators?

Read: Since the Aurora (Gasoline Co., Detroit) unit was installed in 1947, we have used monolithic lining in regenerators very extensively and successfully.

In gunite lining of a tube still, what precautions should be taken to prevent spalling?

Tinsley: The type of refractory material which will resist spalling should be very carefully selected. Only in the last few years have refractory materials been used for this service. The refractory manufacturers have done a lot of development work on castables to resist spalling and penetration, to increase insulation properties and at the same time increase abrasion resistance.

It is quite obvious that some characteristics are combined there which do not go together. Most all manufacturers of refractory materials will take one product and put emphasis on the resistance of one product to spalling: with another product emphasis is placed on resistance to abrasion, load bearing and density.

The best answer to this problem is in the selection of the base material used. Most all of the large refractory manufacturers will have one product which has fairly high resistance to spalling.

From floor: **Does the amount of water used in the mixture and the method of application have any effect on spalling?**

Tinsley: It will if too much water is used in the mixture to cause some segregation which would increase spalling. The application method very definitely has a lot to do with it. If the proper water content is used with proper application, actual practice will simulate what the manufacturers' tests would show. Have someone doing the work who knows what he is doing. Generally speaking, the supplier can specify the proper water ratio but, when the workman starts guniting, remember there is a water hose connected to the end of the gun and sometimes the gunite gets pretty wet.

From floor: **Isn't there a better way, such as putting in a reinforcing material?**

Tinsley: That is another thing to be careful about. If reinforcing material is used which has a wide difference in the coefficient of expansion when compared to the refractory material, this can cause a parting, resulting in what could be called a "mechanical spall."

From floor: **Isn't it also very important to make sure that there is no overlay over reinforcing material?**

Tinsley: Yes it is. Where hex steel is used any excess should be trimmed off—very carefully trimmed off—because otherwise that excess material is going to erode or spall off just as soon as operations start.

From floor: **If you had reinforcing material some distance below the surface of the insulating material, this would not cause spalling?**

Tinsley: That would depend somewhat on vessel temperatures—inside and outside—and where reinforcing is placed. Generally speaking, we do not like to put an anchoring or reinforcing body in the center of a refractory body which will predispose for a line of cleavage—it doesn't make much difference how deep or how shallow it might be. We like to anchor pretty well through a probable line of cleavage rather than encourage it by anchoring with hardware cloth or something of that nature.

Fischbeck: We are very fond of using gunite lining. Nearly all the Cycloversion desulfurization and reformer units are gunite lined. Also, we have lined many types of vessels used in other processes. Excluding cat crackers, we prefer not to use hex steel, chicken wire, or similar anchoring and supporting arrangements.

For most applications stainless steel "jaggers" are preferred. The jagger is merely a wise stud, welded to the wall on four to six inch random centers. It is bent at right angles on the protruding end. These jaggers, on a 6-in. lining, extend out from the wall 4½ in., so they are buried in the lining to the extent of 1½ in., or approximately so.

When guniting the interior of a vessel, the nozzle man gives himself an exterior coating while the vessel wall receives an interior lining. It is not very clean work inside a vessel. When guniting a 6-in. lining, depth gages are placed on 2-ft. random centers to guide the nozzle operator. During lining application, the nozzle is kept in motion at all times to build up the lining uniformly. When lining a 10-ft. diameter vessel, the bottom is lined first; then the walls are gradually built up and finally the dome.

The lining should be completed in one operation, if possible. Six percent or less water is mixed with the lining material ordinarily used. Too much water has a tendency to weaken the lining. After applying, the lining is kept moist for a period of 24 hours, using a fine water spray or exhaust steam, followed by heat curing for 48 hours.

We have not used this particular type of internal lining on cat crackers, but we probably will when a new unit is constructed or when one of the operating units requires lining replacement. It should work very well.

The cost of the lining will depend on whether or not you own a gunite machine, the type of material you are using, and the application in question.

From floor: **Have you ever had any experience with this jagger type of anchoring, of bringing the stud bolts out—say on 4-in. centers—so the one next to it might be three?**

Fischbeck: Jaggers of different lengths in a lining have been successful.

From floor: **Do you ever have spalling troubles from them?**

Fischbeck: No, not spalling troubles. It takes a ball-peen hammer and chisel, or a jack hammer, to chip them.

From floor: **What kind of refractory material have you used?**

Fischbeck: For lining Cycloversion reactors, we are using "Quigley's Plastic Insulcrete." Its insulating properties are not all that could be desired, though sufficient. In order to get a good bond and have adequate strength, 6-in. linings are preferred. However, good service has been experienced with 3, 4, 6 and 9-in. linings. Bed-type reactors lined by our methods, when operating at 1060 to 1080° F, ordinarily have wall temperatures in the order of 200 to 300° F.

From floor: **What would you use for corrosion resistance with a cracking stock?**

Fischbeck: About a 2-in. lining on 1 or 1¼-in. jaggers. Even if you do have a break, it will probably be a very small hair-line crack that does not extend in depth to the vessel wall.

From floor: **Have you partially lined towers?**

Fischbeck: In our work, towers have been partially lined without any difficulties.

Tinsley: I would like to add one comment to what Mr. Fischbeck has had to say. His idea of continuous application is very good, but if you must stop part way through, have the applicator cut off at some point and level a bench on the lining to full thickness to leave a level starting point. You are likely to have a minor crack at this point but it is likely the next day—or the next three or four days for that matter—the application can be continued without any serious bad effects. This often has been done on large installations.

What has been the experience with using hex grating or wire mesh to reinforce gunite linings?

Tinsley: This has been covered partly in answering other questions. The primary purpose in using hex grating is to help the lining resist abrasion. Those of you having linings reinforced with hex gratings have probably noticed that it tends to cut to some extent in the grating openings, wearing pretty well against the steel. Experience generally has been good with hex grating although there is one precaution I think should be taken.

There has been at least one bad experience that I know of in using a higher alloy hex grating possessing a high expansion coefficient — much higher than the refractory castable used with it. Expansion tended to break up the surface of the monolithic lining. It was finally necessary to entirely remove the alloy grating and substitute a plain carbon steel hex grating.

How can gunite linings be installed to prevent plugging of valves in the regenerator standpipe in the event of regenerator lining failure?

Tinsley: I do not believe it can be done. Maybe one of the process experts can answer.

Read: The best insurance against valve plugging is to anchor properly, cure and dry the lining.

Is there a simple method of installing castables?

Tinsley: It all depends upon what one calls "simple." There are three methods: pouring, slap-troweling, and guniting. For pouring, expensive forms must be built. Troweling will encourage spalling. Guniting is messy.

A type of gun has been developed which will wet mix and pump the material to the nozzle for spraying on the surface being treated. My company has done considerable work on this and it has great possibilities. The principal advantage of this type of equipment is a reduction in the rebound losses. This subject has not been touched on, but it is quite obvious that a premixed wet mixture applied to a wall will stick much more tightly than a mixture which is delivered dry to a nozzle and water added at that point. We have made several successful applications. In using this type machine, I recommend that your men be thoroughly trained by the machine manufacturer.

What are the advantages of using castables over brick linings in cat-cracker regenerators?

Tinsley: I assume this means a brick lining in service. If so, there are no advantages unless a sufficient thickness of castable is used to permit anchoring through the brick-work. Applying castables directly to a refractory lining in service would not stay there long without anchorage, in my opinion.

There is only one reason I can think of for considering it; to seal air-leaks which might have developed in the brick lining. There are other materials than castables which are better adapted to such service. A very thin coating—perhaps an eighth of an inch—of refractory coating of the high-temperature cement type would be advisable. There are prepared mixtures available which can be used to successfully fill cracks up to ¾-in. wide. To my knowledge only a specially prepared mixture could be used to coat over brick linings to any very great depth.

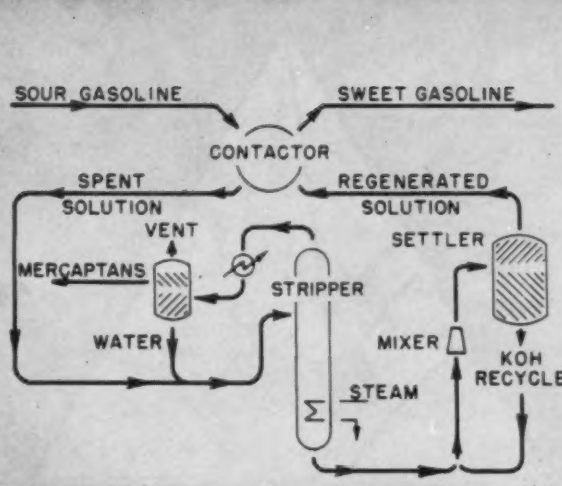
From floor: **Would you recommend putting gunite over gunite?**

Tinsley: I doubt seriously if it would stay unless the anchorage was brought through to include the new material. Mr. Anderson may have comments.

Anderson: We have been having a little bit of trouble; I do not know that it is unusual. The regenerator on our unit was lined with 4-in. of one-component, gunite-applied refractory and, contrary to the recommendations just made, we have reinforcing wire in a plane. Perhaps that is the cause of the trouble. The wire is 4 x 4 wire 2½ in. in from the hot surface. A year ago we inspected this lining and found some cracks running approximately radially but they were not severe enough to cause any trouble. We had done some minor patching when that difficulty appeared before.

When we came down about the end of September (1953), we found the lining had spalled very badly, to the extent that with a screw-driver relatively large pieces could be pried out. Some were 3 in. square. Spalling definitely was not confined to the plane of the reinforcing wire or any particular plane, because the pieces which came off ranged from a minimum of ¾-in. up to 2½ and 3 in. thick.

We know of no operational upset, excessive temperatures, or temperature swings during the past year which would account for this. Our experience with this type of lining is limited; we have just the one unit. I would very much like to know if our experience is unique or if we can just expect to put a new lining in this vessel every three years. I am not acquainted with the problems refractory manufacturers have but certainly we are not totally satisfied with what we have today; we would like to have something better.



NEW "DUALAYER" PROCESS for sweetening gasoline developed by Magnolia Petroleum

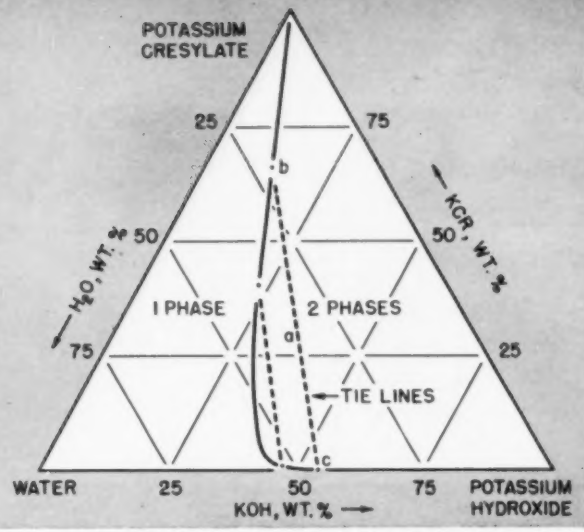


FIG. 1—Phase diagram, potassium hydroxide—potassium cresylate—water

Twist a Problem into a Profit

By C. A. DUVAL and V. A. KALICHEVSKY
Magnolia Petroleum Co., Beaumont, Texas

A NEW gasoline treating process has been developed at Magnolia Petroleum Co. for the highest possible extraction of mercaptans. It will be used in a full-scale unit now under construction at the company's Beaumont, Texas, refinery.

It takes advantage of what was heretofore regarded as a problem in using conventional caustic treating solutions containing organic acids. At certain concentrations, two immiscible layers are formed which are also immiscible with the oil being treated. Commercial processes now in use employ one-phase solutions of a composition fairly remote from this critical region in order to avoid such separations.

The new process uses these two layers and is therefore referred to as the "Dualayer" process. The principles on which it is based are applicable to a large variety of systems involving alkali hydroxides, water, and organic substances. Close control of the contents of the three components of the treating solution makes possible the success of the new two-layer technique.

Use of the process is not limited to gasoline. It can be applied successfully to the refining of considerably heavier petroleum distillates, such as kerosine and distillate fuel oils, which are not treated satisfactorily with conventional mercaptan extraction processes.

Extraction, rather than conversion to disulfides, is preferable for the mercaptans in petroleum products, because of the reduction in sulfur content in the treated distillates. Disulfides left in the oil may even be more harmful to quality than the original mercaptans.[2] The importance of complete removal of mercaptans from gasoline, as compared with their conversion to disulfides, may be visualized from the data presented in Table 1.

A higher octane rating, in three different gasolines, results from Dualayer treating (for complete mercaptan removal) than from doctor treating. As shown, savings of $160 per 1000 bbl. of product in TEL costs are not unusual because of the increase in octane number of the leaded gasoline.

Considerably greater savings can be obtained in many instances, depending upon the quantity of mercaptans present and the desired octane number of the product. The Dualayer process secures a doctor sweet product by extracting mercaptans and not converting them to disulfides which remain in the oil.

Mercaptans are acidic and alkalies react with them. However, alkalies alone are seldom capable of extracting all mercaptans with the possible exception of the lightest members of the series. Complete removal of mercaptans from petroleum distillates with conventional aqueous alkali hydroxides is attained only in very rare instances.

Addition of organic acids, referred to as solutizers or solventizers,[3] improves the mercaptan extraction efficiency of aqueous alkali hydroxide solutions. However, improvement obtained by existing processes is seldom adequate to insure sufficient removal of mercaptans to give products sweet to the doctor test.

A typical flow diagram for a commercial process is shown above. It is only one of the possible variations of the flow of materials which was found to be the best for solving a particular refinery problem. It uses potassium hydroxide, water, and cresylic acid.

Gasoline distillate containing mercaptans enters a two-stage, countercurrent extraction system at the contactor. The small quantity of the treating solution employed favors the use of mixing and settling stages in preference to tower extraction.

Doctor sweet gasoline is pumped to storage and the spent treating solution

Dualayer for Fuel Oil

The new two-layer treating process will also be used by Magnolia for stabilizing distillate fuels with respect to color, sediment formation, and sweetening. A paper on this process will be presented at the 19th mid-year meeting of the Division of Refining, American Petroleum Institute, Houston, May 13, by C. A. Duval, R. T. Malin, and V. A. Kalichevsky. See special API Section, this issue, beginning p. 704. Information in this article comprises the major portion of a paper, "Dualayer Gasoline Treating Process" by Duval and Kalichevsky, presented at the Western Petroleum Refiners' Ass'n. annual meeting in San Antonio, March 28-31.

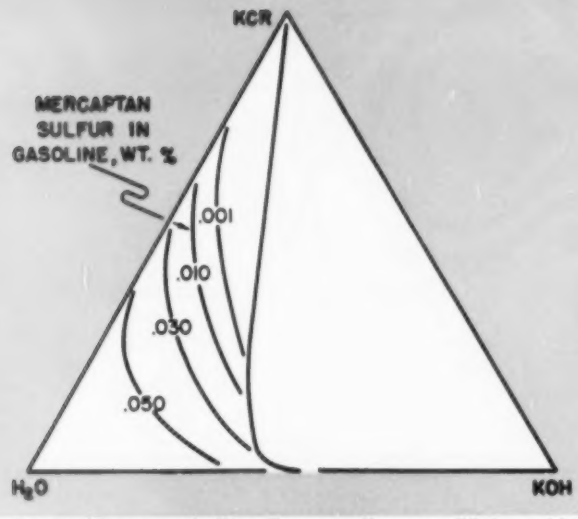


FIG. 2—Mercaptans in West Texas gasoline at equilibrium with treating solution

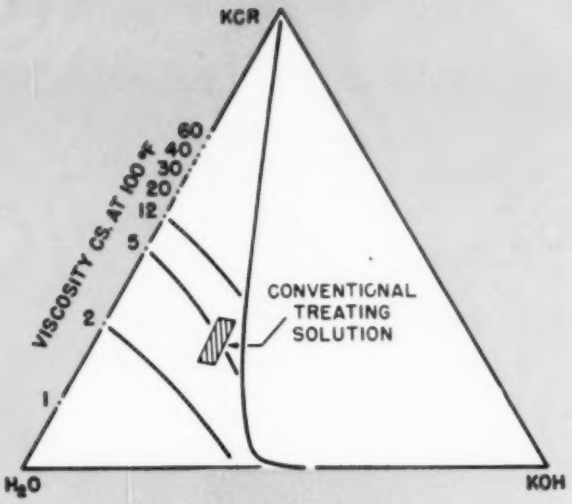


FIG. 3—Viscosity of the treating solution

is diluted with an equal volume of water and settled (in equipment not shown) to remove small quantities of entrained gasoline. The diluted solution is directed to the regeneration tower (stripper), equipped with closed steam coils. Water, added to the treating solution in the previous step, is converted into stripping steam by these closed steam coils. It is removed as a liquid on the water separation tray in the upper portion of the column, and is used for diluting the stream of the spent solution.

Vapors from the stripper are condensed and the mercaptans removed from the system; while the water layer returns to the top section of the stripper tower.

The lean treating solution (stripper bottoms) is blended with a small quantity of 50° Be′ potassium hydroxide and then fed to the Dualayer equilibrium drum. The two layers are separated, and the top layer, containing the potassium cresylates, is used as the treating solution. Small quantities of potassium cresylate solution may be withdrawn from the system if excessive quantities of cresylic acid are present in the raw gasoline distillate.

Potassium hydroxide has a considerable advantage over sodium hydroxide for extraction of mercaptans. On account of their low viscosity, potassium hydroxide solutions can be used commercially in highly concentrated form. The mercaptan extraction power of these concentrated solutions is high. Losses of potassium hydroxide due to entrainment are less than with sodium hydroxide because of this difference in viscosity. For this reason, in regenerative processes the cost of potassium hydroxide is usually less than that of sodium hydroxide and the extractive power is greater.

Cresylic acid is a mixture of acidic organic substances present in the petroleum distillates from which the mercaptans are removed. Caustic solutions extract these compounds and no outside source is normally required to supply them to the process. In the few instances where distillates are deficient in these acids, they may be obtained from treating other refinery stocks. Composition of cresylic acid from petroleum varies with the nature of the distillate but these variations are minor and do not affect the process efficiency.

Three-component systems are conveniently represented by triangular diagrams. A typical diagram for potassium hydroxide, water and potassium cresylate system is given in Fig. 1. In this instance cresylic acids extracted from catalytically cracked gasolines were employed.

Cresylic acids from other sources may slightly affect the position of the boundary line separating the one- and two-phase regions. The tie line *a* on the diagram shows the composition of the two layers if the total composition of the mixture corresponds to any composition intersected by the line. The actual compositions of the two layers are represented by points *b* and *c*.

Several factors must be considered in choosing the most desirable composition of the treating solution for commercial use. The most important of these are the extraction power for mercaptans and viscosity.

Extraction power of solutions for mercaptans may be visualized from concave curves on Fig. 2. They show that the extraction efficiency improves as the curves approach the two-phase region. It also improves with the change in composition of the treating solution as it nears the KCr apex of the triangular diagram given in Fig. 2. In the diagram KCr is used as an abbreviation for potassium cresylate and H_2O and KOH are the conventional chemical symbols for water and the uncombined potassium hydroxide.

Viscosities of the solutions are represented by the convex curves on Fig. 3. Viscosities decrease as the curves approach the H_2O apex on the diagram. Separation of treating solution from the treated distillate is a function of the viscosity of the treating solution. Good separation is obtained with solutions having viscosities below 12 centi-

Table 1—Typical TEL Savings for Dualayer Process Over Doctor Treating

Gasoline	Oct., R-39—3 cc. TEL Doctor	Dualayer	TEL Savings* $/1000 bbls.
Absorption	84.0	85.6	90
Thermal	83.2	86.0	160
Straight-run	85.9	87.2	70

* TEL @ 0.231¢ per cc.

Table 2—Mercaptan Removal by Dualayer and Solutizer Solutions From West Texas Gasoline

Treating Solution	Sol./Gasol. Volume ratio	Mercaptan Removal, % One Stage	Two Stages	Three or more
Dualayer	0.02	91	100	100
Solutizer	0.20	71	80	93
Solutizer	0.40	84	93	96

NOTE: Initial Mercaptan Sulfur, 0.110 wt.-%.

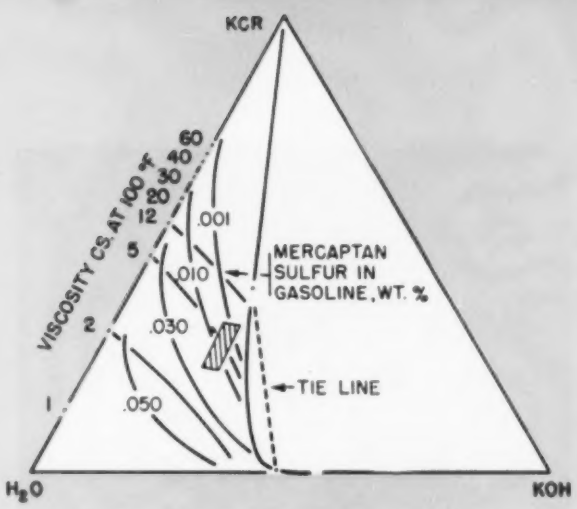


FIG. 4—Mercaptans in gasoline at equilibrium and viscosity of the treating solution

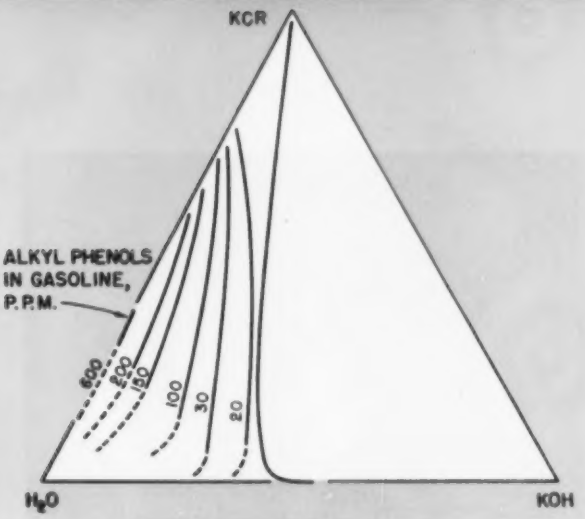


FIG. 5—Alkyl phenols in gasoline at equilibrium with treating solution

stokes at 100° F. Solutions of considerably higher viscosity can be used successfully with proper mixing and settling equipment and with continuous filtration of the solution to remove impurities.

Fig. 4 shows that for a given viscosity, the highest extraction efficiency is obtained by a solution having a composition on the two-phase boundary line. This is true for viscosities above 5 centistokes at 100° F. Extraction efficiency and viscosity lines in Figs. 2 and 3 are superimposed in Fig. 4.

Equilibrium curves for cresylic acid concentrations in the treating solution and in gasoline are shown in Fig. 5. These curves are important for calculating the amount of cresylic acids introduced with the fresh distillate that will be absorbed by the treating solution or released to the distillate.

The shaded regions on Figs. 4 and 5 represent compositions of conventional treating solutions recommended for use commercially at the present time. It may be seen that the ultimate ability of these solutions for extracting mercaptans has not been utilized. This is also demonstrated by the data presented in Table 2 on mercaptan extraction by the Dualayer and conventional solutizer solutions from a West Texas straight-run gasoline.

The data are presented on percentage basis for better visualization. The 100% removal of mercaptans corresponds to a product sweet to the doctor test and containing less than 0.0005 wt.-% mercaptan sulfur.

The tabulated data show the ease with which the mercaptans are removed from the oil by the Dualayer process. With the conventional treating solutions, the doctor sweet products could not be obtained even by raising the solution to distillate ratio more than twenty times above that employed in the new process.

The exceptional performance of the Dualayer process is due to the fact that the potassium hydroxide, potassium cresylate and water content of the treating solution are completely under control. Treating solution composition on conventional solutizer units is normally out of control and reaches an unfavorable equilibrium for mercaptan extraction. The water content or boiling point of the solution is usually the only method used to adjust composition and the potassium hydroxide to potassium cresylate ratio varies until it reaches equilibrium with the organic acids in the oil.

The resulting solution is deficient in potassium hydroxide and is relatively ineffective for the extraction of mertaptans. High treating ratios and large strippers are required for even partially satisfactory results.

In the Dualayer process the water content and the potassium hydroxide content are both controlled. The water content is controlled by the stripper temperature and the potassium hydroxide content by the equilibrium with the potassium hydroxide-water layer in the equilibrium drum.

Since the solution consists of only three major components, control of two of them automatically controls the third. In other words, the Dualayer solution has only one degree of freedom and the stripper temperature controls its composition. Conventional solutions, with only one homogenous phase, have two degrees of freedom and cannot be controlled satisfactorily by the stripper temperature alone.

Regeneration is easy with the Dualayer solutions. Less than 10 lbs. of steam per bbl. of gasoline charge was needed in the pilot unit to remove mercaptans from the treating solution used in the experiments reported in Table 2.

Several modifications of the regeneration procedure are possible. The coexistence of three layers—gasoline, potassium hydroxide and potassium cresylate—in equilibrium with respect to mercaptan concentrations shows that either of the two alkali layers will reduce the mercaptan content of the gasoline. However, the favorable equilibrium conditions are established on account of the tremendous absorptive capacity of the potassium cresylate layer for potassium mercaptides. In the absence of the potassium cresylate layer, mercaptans distribute relatively evenly between the gasoline and potassium hydroxide solution and their extraction becomes difficult. If the spent potassium hydroxide solution from treating is brought in contact with the potassium cresylate layer, mercaptans are absorbed by this layer and the potassium hydroxide solution regenerated.

Regeneration of mercaptans from the potassium cresylate layer is accomplished by diluting with water and steam stripping the diluted solution. Since the required potassium cresylate to gasoline treating solution dosage is very low, in some cases it may be as low as 2 vol.-%, only a small quantity of water is required to provide very dilute solutions for stripping. The advantages of stripping dilute solutions may be visualized from Fig. 2. The ease of stripping is inversely proportional to the mercaptan extraction ability of the solution and water dilution reduces the mercaptan extraction power of the solution.

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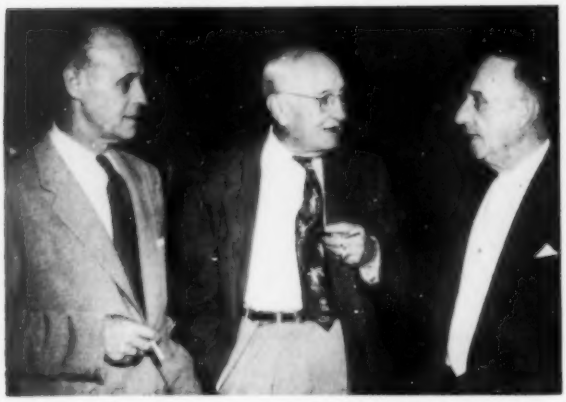
(1) Duval, C. A., *Petroleum Refiner*, Vol. 30, No. 2, p. 85 (1951).
(2) Hanson, T. K., and Coles, K. F., *J. Inst. Pet.*, Vol. 33, pp. 589-97 (1947).
(3) Kalichevsky, V. A., *Petroleum Refiner*, Vol. 30, No. 4, pp. 111-117 (1951).



"IT WAS THIS WAY . . ." Paul D. Williams, WPRA technologist; L. B. Simmons, Rocket Oil Co.; John Day, WPRA secretary-treasurer

"WHAT'S ON THE PROGRAM?" C. C. Ward, U. S. Bureau of Mines and Alan A. Rawlings, Anglo-Iranian Oil Co.

With the WPRA in 'San Antone'

NEW OFFICERS FOR 1954: l to r; H. J. Kennedy, vice president (vice president for sales, Continental Oil Co.); J. W. Vaiden, vice president (vice president for manufacturing, Skelly Oil Co.); Roland V. Rodman, president (president, Anderson-Prichard Oil Corp.); and Reid Brazell, vice president (president and general manager, Leonard Refineries, Inc.). NOTE: a fourth WPRA vice president, newly-elected, is F. L. Martin (president, Suntide Refining Corp.), not in the picture.

FOR FURTHER REPORTS in this issue on activities at the annual meeting of the Western Petroleum Refiners Ass'n. in San Antonio, March 29-31, see:

"More Light Ends in Motor Fuels Seen as Stopper to Profit Leaks" ..... p. 631
"Twist a Problem into a Profit," an article on the new Dualayer Process ..... p. 691
"What Amyl Nitrate Does to Improve Diesel Fuel" ..... p. 684

"SO HE SAID TO ME . . ." Charles Ridgeway, Pure Oil Co., and T. J. Sullivan, Gulf Oil Corp.

"AND I SAID TO HIM . . ." Macauley Carter, Arthur G. McKee and Co., and Lee Haugen, Cities Service Oil Co. (Del.)

"MEET MY DAUGHTER . . ." Brown L. Meece, Sinclair Refining Co.; Rex S. Blazer, Ashland Oil & Refining Co., and Miss Mary Blazer

"MORE ON THE DISTAFF SIDE" E. J. Slater, Champlin Refining Co.; L. L. Huxtable, Ethyl Corp.; and Mrs. Slater

"SERIOUSLY, NOW . . ." H. R. Wall, Continental Oil Co., and J. L. Anning, Rockwood Sprinkler Co.

"THAT'S A GOOD ONE . . ." O. D. Edwards and George M. Brooner, both of Perco Division, Phillips Petroleum Co.

"IT WASN'T THAT BAD . . ." J. Y. Haslam and J. D. Waddell, Skelly Oil Co., and J. C. Bradley, Anderson-Prichard Oil Corp.

"TALK ABOUT FUN! . . ." A. H. Hahn, Crane Co. Valve Division, and M. O. Kilpatrick, Phillips Petroleum Co.

Statistics for Everyday Use

Techniques for applying this useful tool in the plant, pilot plant, or laboratory—Part 2

By C. T. SHEWELL
Humble Oil & Refining Co.
Baytown, Texas

PROPERLY used, statistics can be a powerful tool in solving many perplexing problems in refinery and petrochemical processing plant operations. Statistics can be applied with success to engineering, to research and development, to purchasing, and many other activities, in addition to manufacturing.

Almost $300,000 was saved, for example, in one particular operation in the author's company, as was pointed out last month in the first article in this series, where statistical evaluation was applied to testing methods and blending procedures for automotive gasoline.

The first three of nine different statistical techniques were discussed in the first article—measures of central tendency, measures of dispersion, and discarding of bad data. This month's article will cover: the "Student's 't' test," the least squares curves, and propagation of error.

Students' "t" Test

It is frequently necessary to decide whether a new method or process or product is better than some standard method or process or product, so data are obtained upon which decisions may be based. In the past these decisions have been made without regard to whether the observed differences were statistically significant or not. Undoubtedly, many such dicisions have been based on statistically inadequate data (that is, a large risk was involved of being wrong), and either errors were not made because of exercising extremely good engineering judgment or it has not been possible to detect some of the errors that were made.

The t test is a tool to supplement engineering judgment. Assume, for example, that according to the t test there is no significant difference at the 5% α risk level, and there is at the 10% level in two sets of data being compared. If engineering judgment indicates a difference and action is taken on that judgment, then a risk of being wrong between 5 and 10% has been taken. Unless such tests are made, the risk being taken is unknown and may be large.

A—Comparing a Sample with a Standard

This is a very common case in industry since products are constantly being tested to see if they meet a specification which is the standard. If μ is called the standard value and $\overline{X}$, s, and N the data on the sample, then

$$t = (|\mu - \overline{X}|) / (s/\sqrt{N})$$

is the value of the t statistic for the sample, and Table 2 gives the maximum values for t for a number of α risk levels and degrees of freedom. The degrees of freedom to use in entering the table are those associated with s, the standard deviation of the sample. This is always N—1 for this case.

As an example, data on a gasoline which was produced in an effort to meet a specification of 94.0 research octane number may be examined.

It is not known, before testing, whether the blend will be above or below 94.0 in quality, and this then is the so-called, two-tailed t test. If a negative quantity is obtained, the standard will be exceeded and the sample will be in the right-hand tail, and if a positive difference is obtained, the sample is in the left-hand tail of the t distribution.

If either difference is large enough, the hypothesis that there is no difference between the standard and sample is

Table 2—Distribution of "t"

Probability of Occurrence, P_t

d.f.	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.001
1	.158	.325	.510	.727	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619
2	.142	.289	.445	.617	.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598
3	.137	.277	.424	.584	.765	.978	1.250	1.638	2.353	3.182	4.541	5.841	12.941
4	.134	.271	.414	.569	.741	.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610
5	.132	.267	.408	.559	.727	.920	1.156	1.476	2.015	2.571	3.365	4.032	6.859
6	.131	.265	.404	.553	.718	.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959
7	.130	.263	.402	.549	.711	.896	1.119	1.415	1.895	2.365	2.998	3.499	5.405
8	.130	.262	.399	.546	.706	.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041
9	.129	.261	.398	.543	.703	.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781
10	.129	.260	.397	.542	.700	.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11	.129	.260	.396	.540	.697	.876	1.088	1.363	1.796	2.201	2.718	3.106	4.437
12	.128	.259	.395	.539	.695	.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13	.128	.259	.394	.538	.694	.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221
14	.128	.258	.393	.537	.692	.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140
15	.128	.258	.393	.536	.691	.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16	.128	.258	.392	.535	.690	.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015
17	.128	.257	.392	.534	.689	.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965
18	.127	.257	.392	.534	.688	.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922
19	.127	.257	.391	.533	.688	.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20	.127	.257	.391	.533	.687	.860	1.064	1.325	1.725	2.086	2.528	2.845	3.850
21	.127	.257	.391	.532	.686	.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819
22	.127	.256	.390	.532	.686	.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23	.127	.256	.390	.532	.685	.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767
24	.127	.256	.390	.531	.685	.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25	.127	.256	.390	.531	.684	.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725
26	.127	.256	.390	.531	.684	.856	1.058	1.315	1.706	2.056	2.479	2.779	3.707
27	.127	.256	.389	.531	.684	.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690
28	.127	.256	.389	.530	.683	.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29	.127	.256	.389	.530	.683	.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659
30	.127	.256	.389	.530	.683	.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646
40	.126	.255	.388	.529	.681	.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551
60	.126	.254	.387	.527	.679	.848	1.046	1.296	1.671	2.000	2.390	2.660	3.460
∞	.126	.253	.385	.524	.674	.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291

NOTE: The above table has been abridged from Table III of Fisher and Yates: Statistical Tables for Biological, Agricultural, and Medical Research; published by Oliver and Boyd, Ltd., Edinburgh, by permission of the authors and publishers.

rejected. In other words, the hypothesis will be rejected if the sample is either significantly better or significantly worse than the standard. Consider the following data:

93.8	94.2
94.3	93.6
93.9	93.2
94.1	93.6
93.4	94.0

For illustration, a 5% risk is chosen, both for rejecting a single value from these data and for the t test. Using the test for discard of single values, as shown last month, p. 527:

$$\Sigma X = 938.1$$
$$\overline{X} = 93.81$$
$$(93.81 - 93.2)/0.209 = 2.9186 \text{ (tabulated } 2.93)$$

All values are retained. Testing against standard:

$$\Sigma X^2 = 88004.31$$
$$s = 0.357$$
$$t = (\mu - \overline{X})/(s/\sqrt{N})$$
$$= (94 - 93.81)/(0.357/\sqrt{10})$$
$$= 1.682$$

Referring to Table 2, in the column headed 0.05 and in the row headed 9, 2.262 is obtained. Hence, the hypothesis is accepted as true and the gasoline is acceptable for shipment.

B—Comparing Two Samples

In the previous example it was seen that the t test depended upon the value of the standard deviation of the sample and the degrees of freedom associated with it. Somehow, then, when considering two samples it is necessary to take into consideration both values of s and their associated degrees of freedom. In order to do this a "pooled" standard deviation is needed and is calculable by either of the two formulas given below, which are algebraic identities.

$$s_p = \sqrt{\frac{\Sigma X_1^2 - \frac{(\Sigma X_1)^2}{N_1} + \Sigma X_2^2 - \frac{(\Sigma X_2)^2}{N_2}}{N_1 + N_2 - 2}}$$

$$= \sqrt{\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2}}$$

Here again it is not known which set will have the larger average, so a two-tailed test is used with the following formula:

$$t = \frac{|\overline{X}_1 - \overline{X}_2|}{s_p\sqrt{1/N_1 + 1/N_2}}$$

The table is entered with the desired α risk and $N_1 + N_2 - 2$ degrees of freedom.

To illustrate, data obtained for catalysts from two process units, No. 1 and No. 2, are to be tested. The hypothesis is made with 5% risk that there is no difference between the two D + L values and the data are examined by the t test:

Unit No. 1			Unit No. 2	
32.9	32.1	29.8	25.8	21.2
34.0	28.2	33.3	21.8	23.6
32.9	32.0	31.4		

The standard deviation for replicate test values of this character is 0.84 for 23 degrees of freedom.

Testing for discard of single values on Unit No. 1:

$$\Sigma X_1 = 286.6$$
$$\overline{X}_1 = 31.84$$
$$N_1 = 9$$

$(31.84 - 28.2)/0.84 = 4.33$

The tabulated values are such that even at 0.1% (4.02), the 28.2 value should be discarded, leaving:

$$\Sigma X_1 = 258.4$$
$$\Sigma X_1^2 = 8358.12$$
$$N_1 = 8$$
$$\overline{X} = 32.30$$
$$s_1 = 1.30$$

Then, for Unit No. 2:

$$\Sigma X_2 = 92.4$$
$$\overline{X}_2 = 23.10$$
$$N_2 = 4$$

$(25.8 - 23.1)/0.84 = 3.214$

The tabulated values are still such that we discard even at 0.5% (2.93), and therefore, 25.8 is discarded, leaving:

$$\Sigma X_2 = 66.6$$
$$X_2^2 = 1481.64$$
$$N_2 = 3$$
$$\overline{X} = 22.2$$
$$s_2 = 1.25$$

$$s_p = \sqrt{\frac{(8-1)(1.30)^2 + (3-1)(1.25)^2}{8+3-2}}$$
$$= 1.29$$

$$t = (32.30 - 22.20)/(1.29\sqrt{1/8 - 1/3}).$$
$$= 11.55 \text{ with 9 degrees of freedom.}$$

The tabulated 5% value is 2.262, so it may be said that there is a difference in the D + L values of the catalysts in the two cracking units, with at most 5% risk. Actually, even the tabulated value for 0.1% risk is greatly exceeded.

Least Squares Curves

Research people are constantly drawing curves through data points to represent graphically what the relations are between two variables. In many instances these curves are "eyeballed" or drawn freehand (with the aid of a French curve) without due regard to the symmetrical scatter of the data about the curve, and in too many instances without regard to the adequacy of the data.

Consider the case where the research worker knows from some source that when the data are plotted on a certain kind of cross-section paper, a straight line will be obtained over the entire range of interest. In this case, the most efficient way to collect the data is to divide the total number of pieces of data that can be obtained, or is wanted, into two equal groups and obtain each group at an extreme of the field of interest.

Note that nothing has been said about the form of the equation postulated as giving a straight line. For example, it might be that ln k vs. 1/T will give a straight line, as for a first order reaction, etc.

Similar reasoning applies to higher order curves than a straight line. If a second order curve is postulated, three equally spaced equal groups of data should be obtained; for a third order curve, four equally spaced equal groups of data should be obtained; and so on. It must be emphasized that the form of the equation should be selected by the technical man, if possible, before starting the experiment, to take full advantage of proper planning of the experimental work.

If, for any reason, the form of the equation is not known, then the best possible way to collect the data is in equally spaced intervals of the independent variable which will be plotted on the X-axis. If this is done, statistics will enable determination of whether a second order curve fits the data better than a straight line, for example, but at least two more points must be obtained than the highest order curve expected; i.e., four points if second order, five if third order, etc.

The equation for any straight line has, in general, two constants, and, to determine each constant from the data, an equation is needed. Since these two constants each apply to all the data points, two simultaneous equations in these constants are needed which have all the data in the numerical parts of the equations in order to be able to determine the constants.

If X is designated the independent variable (whatever its actual form) and Y the dependent variable (again regardless of its actual form), then the equation of a straight line relating these two variables must have the form $Y = aX + b$. "a" is the slope of the line and "b" is its intercept on the Y-axis, and the numerical values for "a" and "b" are to be found which give the best fitting straight line through the data.

The definition of "best fitting" used almost universally today is that curve which minimizes the sum of the squares of the deviations of the data points from the curve *in the Y-direction only*. It is therefore implicitly assumed there is no error in the data in its position along the X-axis. An entirely different treatment is necessary if this assumption cannot be tolerated. This is encountered when one dependent variable is plotted against another dependent variable.

The differential calculus treats problems of maxima and minima, and by using this tool the two necessary equations in "a" and "b" can be derived:

$$\Sigma Y = a\Sigma X + Nb$$
$$\Sigma XY = a\Sigma X^2 + b\Sigma X$$

To handle computations involving these equations rapidly on a desk calculator, the following example is given:

For a few points whose values are of not over three digits, five sums may be obtained simultaneously on a desk calculator, ΣX, ΣX^2, ΣY, ΣY^2, and ΣXY. The values of X and Y are obviously paired, and if such a pair is placed in the keyboard with the X-value, say, on the extreme right, and the Y-value on the left, squaring this number (considering the intervening rows of keys to have zeros punched in them) will give X on the right and Y on the left of the counter dials, X^2 on the right, Y^2 on the left and 2XY in the center of the product dials.

If the dials are not cleared, and this process is repeated for all pairs of points, then ΣX, ΣY are in the counter, and ΣX^2, and ΣY^2 and $2\ \Sigma XY$ are in the product dials.

Care must be exercised that no "spillover" occurs into any dial. It is best to put the variable with the smallest number of digits on the left of the keyboard, the last place being punched in the seventh column (from the right) of the keyboard, as this allows seven places in the product dials for the right hand sum of squares, seven places for $2\ \Sigma XY$ and six for the left hand sum of squares. The left hand sum in the counter cannot exceed 999 unless there are 11 dials.

A—The Straight Line

In order to clarify this very useful operation, the following calculation on some purely illustrative numbers is given:

X	Y
2	1.0
3	2.6
4	3.4
5	4.8
6	4.4

Since the X-values have fewer digits than the Y-values, place them in the left side of the keyboard, the Y-values being placed on the extreme right of the keyboard. The following results are obtained:

Keyboard	Counter	Product
20000010	20000010	400000400000100
30000026	50000036	1300001960000776
40000034	90000070	2900004680001932
50000048	140000118	5400009480004236
60000044	200000162	9000014760006172

The last line gives the desired sums of 16.2 for ΣY and 20 for ΣX, while $\Sigma Y^2 = 61.72$, $\Sigma X^2 = 90$, and $2\,\Sigma XY = 147.6$, or $\Sigma XY = 73.8$.

Substitution in the so-called "normal" equations results in:

$$16.2 = 20a + 5b$$
$$73.8 = 90a + 20b$$

Although multiplying the first equation by four and subtracting it from the second would eliminate "b" in this case, usually no such simple device exists, so the following solution is the one which will usually be used:

Divide the first equation by the coefficient of "b" (5) and the second by its "b" coefficient (20), obtaining:

$$3.24 = 4a + b$$
$$3.69 = 4.5a + b$$

Now subtract the first equation from the second to eliminate "b" and have the sign of the term in "a" positive, leaving:

$$0.45 = 0.5a$$
$$a = 0.9$$

Now substitute the value of "a" in the first equation, since it is simpler, getting:

$$3.24 = 4(0.9) + b$$
$$3.24 = 3.6 + b$$
$$b = -0.36$$

and the equation is then $\hat{Y} = 0.9X - 0.36$, the "hat" (ˆ) over the Y indicates a predicted, or calculated value of Y from the equation. For example, $\hat{Y}$ for $X = 5$ is $\hat{Y} = 0.9(5) - 0.36 = 4.14$ versus the observed 4.8.

B—Second Order Curves

For a second order curve (a parabola), the assumed form is:

$$Y = aX^2 + bX + c$$

and the three normal equations are:

$$\Sigma Y = a\Sigma X^2 + b\Sigma X + Nc$$
$$\Sigma XY = a\Sigma X^3 + b\Sigma X^2 + c\Sigma X$$
$$\Sigma X^2Y = a\Sigma X^4 + b\Sigma X^3 + c\Sigma X^2$$

These equations again assume X to be free of error, and there is no simple method of handling the data if this assumption is not tenable.

The data above can be used to calculate the best fitting parabola. In addition to the sums already obtained, the following are needed; ΣX^3, ΣX^4 and ΣX^2Y:

$$\Sigma X^3 = 440$$
$$\Sigma X^4 = 2274$$
$$\Sigma X^2Y = 360.2$$

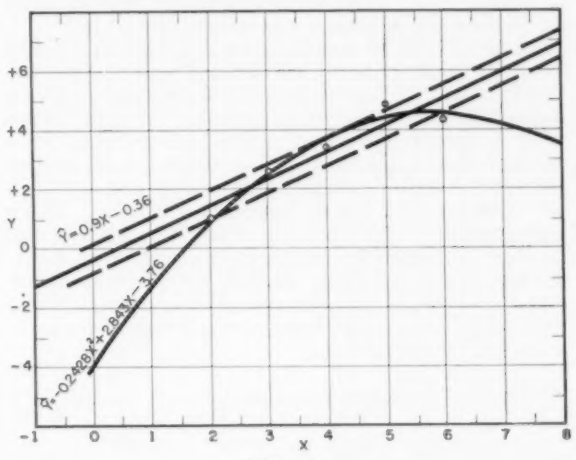


FIG. 1

Substitution in the normal equations gives:

$$16.2 = 90a + 20b + 5c$$
$$73.8 = 440a + 90b + 20c$$
$$360.2 = 2274a + 440b + 90c$$

Dividing each equation by its "c" coefficient gives:

$$(1)\ 3.24 = 18a + 4b + c$$
$$(2)\ 3.69 = 22a + 4.5b + c$$
$$(3)\ 4.0022 = 25.266a + 4.88b + c$$

Now subtract (1) from both (2) and (3) so as to obtain two equations in "a" and "b" with the "b" coefficients positive.

$$(2')\quad 0.45 = 4a + 0.5b$$
$$(3')\ 0.762222222 = 7.266666666a + 0.888888888b$$

Again divide each equation, (2′) and (3′), by its "b" coefficient, and obtain:

$$(2'')\ 0.9000 = 8.000a + b$$
$$(3'')\ 0.8575 = 8.175a + b$$

Now subtract (2″) from (3″), leaving:

$$-0.0425 = 0.175a$$
$$a = 0.2428571428$$

Substitute the value of "a" in (2″) and solve for "b"

$$0.9 = 8(-0.2428571428) + b$$
$$b = 2.842857142$$

Now substitute the values of "a" and "b" in (1) and solve for "c"

$$3.24 = 18(-0.2428571428) + 4(2.842857142) + c$$
$$c = -3.76$$
$$\hat{Y} = -0.2428X^2 + 2.843X - 3.76$$

Note that no rounding off has been done until the final equation is written out: this is important, as discussed earlier.

The data and both the calculated straight line and parabola have been plotted in Fig. 1. Note that in the data field fairly close predictions are obtained using either curve, but if extrapolation outside the field is carried very far, radically different predictions are obtained. This illustrates the danger inherent in extrapolation, where the governing law is not definitely known.

C—The Straight Line with Restrictions

As mentioned previously, the usual method of handling a least squares solution for the equation of a curve, is to assume no error in the X-values; although not explicitly

stated, the assumed form of the equations given allows all of the constants to have any values whatever.

In many cases of interest, either one or both of these conditions must not occur; for example, when plotting yield versus octane number on hydroformed naphtha, both dependent variables have error associated with them; when plotting copper number of an air-caustic treated stock versus time of air blowing, at zero time the curve must go through the copper number of the charge stock.

When situations of this character are encountered, certain adjustments must be made to the least squares equations to allow for these factors. It is unfortunate that similar simple adjustments are not available for second, or higher, order curves, as this lack requires the experimenter to transform his data in such a fashion that a straight line may be used to represent it.

C1—Y Only Subject to Error, but Intercept Must Be Zero

This situation exists in the air-caustic sweetening problem mentioned above. Of course, it is necessary to shift the origin to the copper number of the charge stock by the methods of analytical geometry before starting to calculate, and to restore the origin to its original place after determining the least squares value of the slope in order to have an equation that is usable on the untransformed basis. This is easily done by expressing the copper number at time t as Y_t-Y_c, where Y_c is the charge copper number, and Y_t is the observed copper number at any time t. At $t = 0$, Y_c-$Y_c = 0$, and the condition is fulfilled that the following restricted equation represents the data:

$$Y = aX$$

Since $\Sigma XY = a\Sigma X^2$ for this equation, then $a = \Sigma XY/\Sigma X^2$ gives the value of the slope of the least squares straight line which *must* pass through the origin.

C2—Both X and Y Subject to Error

The only simple solution available where both X and Y are subject to error is a straight line.

This in effect means that any data will have to be transformed or plotted on special paper to obtain a straight line if both X and Y have errors in them in order to evaluate properly the constants in the least squares equation representing the data.

C2a—Intercept Must Be Zero

When the defining equation must have the form $Y = aX$, yet both X and Y have errors associated with them, the value for the slope is determined from the quadratic equation

$$a^2 + a\left[\frac{\Sigma X^2\left(\frac{\sigma_Y}{\sigma_X}\right)^2 - \Sigma Y^2}{\Sigma XY}\right] - \left(\frac{\sigma_Y}{\sigma_X}\right)^2 = 0$$

where σ_Y and σ_X are similar measures of error such as range, average deviation, probable error or standard deviation. It is recommended that standard deviation be used if at all possible, and that if range is used, the two measures of range be on the same sized sample, as range varies with sample size from nearly all distributions.

C2b—Intercept Not Restricted

For the general case, when X and Y are both subject to error, where no restrictions are placed on either the slope or intercept, the defining equations are:

$$b = \frac{1}{N}(\Sigma Y - a\Sigma X), \text{ and}$$

$$a^2 + a\frac{\left(\frac{\sigma_Y}{\sigma_X}\right)^2\left[N\Sigma X^2 - (\Sigma X)^2\right] - \left[N\Sigma Y^2 - (\Sigma Y)^2\right]}{N\Sigma XY - \Sigma Y X\Sigma} - \left(\frac{\sigma_Y}{\sigma_X}\right)^2 = 0$$

D—Are Two Straight Lines Different?

In many instances, such as catalyst testing, there are two (or more) regression lines to be compared with the decision to be made that the lines are the same, or different.

Some method is therefore needed to test statistically the parameters of the lines for significant differences. If these can be shown to be different, the lines are surely different; however, if the intercepts are significantly different then the lines are different irrespective of the slopes; and if the intercepts are not different but the slopes are significantly different, then the lines are also different. It would appear then that there are only two cases to be handled to cover all possible situations involving straight lines.

It is to be noted that nothing has been said about the form of the variables that are linearly related. However, when using any set of scales on the graph paper other than rectangular coordinates, the proper transformations must be used prior to calculating the least squares straight line. For example, if log-log paper is used, the data are transformed to their logarithms before obtaining ΣX, ΣY^2, etc.

In hydroforming catalyst testing work, where the octane number scale is arbitrary, it is necessary to transfer the data onto rectangular coordinate paper with arbitrary X-values of 0, 1, 2, 3, etc. in place of the octane number scale, and then obtain the least squares line. Then the line should be transferred back onto the usual paper for visual comparison, but all the tests of significance should be made on the calculated (transformed) basis.

To illustrate this technique, some data obtained on catalysts No. 1 and No. 2 when operating on the same charge stock will be used.

D1—Are the Intercepts Different?

It is known that there are errors in both the yield and octane number values determined on products from the catalyst testing units, so that the necessary equations are those of section C2, and, for the moment, assume that section C2b (Intercept Not Restricted) applies. Further, let it be assumed that the standard deviation in yields is 1.0% and for octane numbers, 0.35 O.N. The original data are as follows:

No. 1 Catalyst		No. 2 Catalyst	
Yield, %	**Res. O.N.**	**Yield, %**	**Res. O.N.**
77.7	96.2	75.4	99.7
84.4	89.6	79.9	97.1
87.6	85.2	81.2	93.6
87.2	87.8	85.7	88.2

Feed stock quality (100% yield) = 49.1 O.N.

Place a piece of transparent rectangular coordinate paper over the distorted scale paper so that the upper left hand corner coincides with the 100% yield — 49.1 O.N. point, and with the Y-axis parallel to the yield axis.

Label the X-axis main divisions 0, 1, 2, 3, 4, etc. starting with the left hand edge of the paper, and the yield (or Y) values as yield — 100. Now plot the data as if on the usual paper, sighting through the transparent paper to do this. Now read off the X-values from the arbitrary scale and

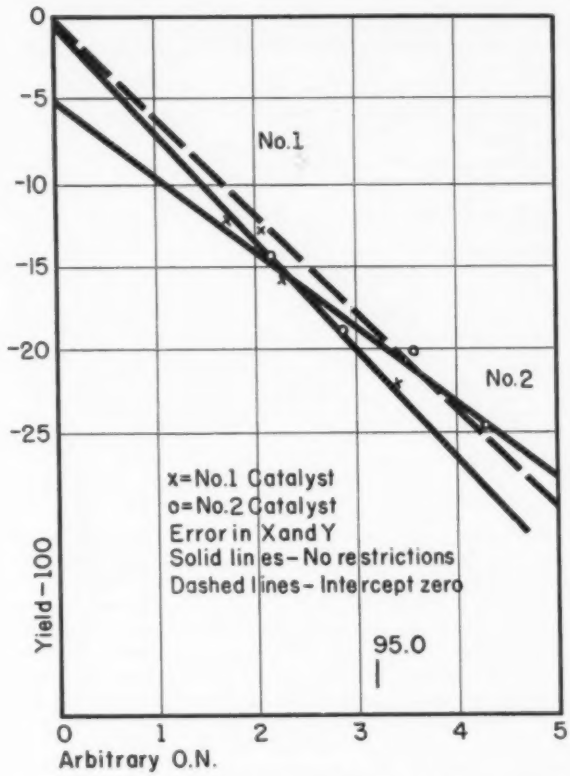


FIG. 2—Method for comparing least squares lines: rectangular scale for data

pair them with the yield — 100 Y-values. These constitute the transformed data to be summed, and are given below. Figs. 2 and 3 are plots of the transformed and original data, respectively.

No. 1 Catalyst		No. 2. Catalyst	
Yield — 100	Arbitrary O.N.	Yield — 100	Arbitrary O.N.
—22.3	3.38	—24.6	4.29
—15.6	2.32	—20.1	3.58
—12.4	1.81	—18.8	2.88
—12.8	2.07	—14.3	2.16

$$\Sigma X_1 = 9.58;\ \Sigma Y_1 = -63.1;\ \Sigma X_1^2 = 24.3678$$
$$\Sigma Y_1^2 = 1058.25;\ \Sigma X_1 Y_1 = -160.506;\ N_1 = 4$$
$$\Sigma X_2 = 12.91;\ \Sigma Y_2 = 77.8;\ \Sigma X_2^2 = 44.1805;$$
$$\Sigma Y_2^2 = 1567.10;\ \Sigma X_2 Y_2 = -262.524;\ N_2 = 4$$

For the No. 1 catalyst (data with the subscript 1) there is obtained:

$$a^2{}_1 + a_1 \times$$

$$\left(\frac{1.00}{0.06}\right)^2 \left[4(24.3678) - (9.58)^2\right] - \left[4(1058.25) - (-63.1)^2\right]$$
$$\overline{4(-160.506) - 9.58(-63.1)}$$
$$-\left(\frac{1.00}{0.06}\right)^2 = 0$$

$$b_1 = 1/4\left[-63.1 - a(9.58)\right]$$

On solving these equations one obtains for the slope: $a_1 = -6.6044$, and for the intercept: $b_1 = +0.0425$.

The σ_x value of 0.06 for the transformed data used in the formula above was obtained from Figs. 2 and 3 as follows:

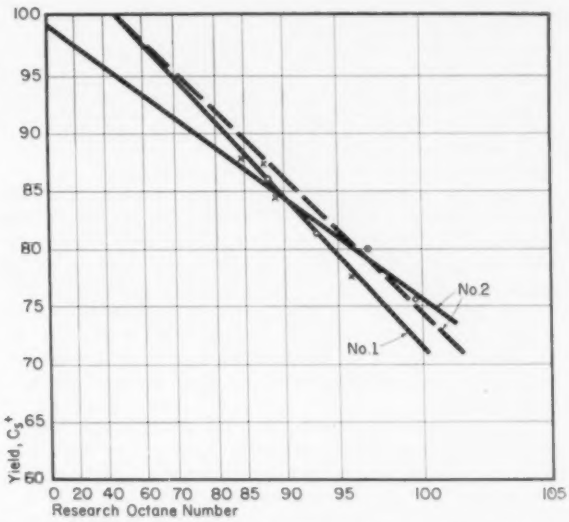


FIG. 3—Method for comparing least squares lines: arbitrary scale for data

Using the determined or known σ_x for the original data (0.35 was assumed for this example), estimate the value of σ_x on the transformed axis by placing Fig. 2 over Fig. 3 and reading through. Do this at each end of the data field and average the results. It may be pointed out that the value of "a," above, is relatively insensitive to fairly wise changes (such as 20-fold) in the value of $(\sigma_y/\sigma_x)^2$.

An exactly similar set of calculations on the No. 2 catalyst data results in: $a_2 = -4.5572$; $b_2 = -4.7416$.

The sum of the squares of the deviations of the points from the lines are next calculated by means of:

$$\Sigma d^2 = \frac{N\Sigma Y^2 - (\Sigma Y)^2}{N} - \frac{(N\Sigma XY - \Sigma X \Sigma Y)^2}{N\left[N\Sigma X^2 - (\Sigma X)^2\right]}$$

so that:

$$\Sigma d_1^2 = \frac{4(1058.25) - (-63.1)^2}{4} - \frac{\left[4(-160.506) - 9.58(-63.1)\right]^2}{4\left[4(24.3678) - (9.58)^2\right]}$$

or:

or: $\Sigma d_1^2 = 1.02956$ and $\Sigma d_2^2 = 1.962210$

The standard deviation of the points from the line is calculated from $s^2 = \Sigma d^2$ (N-2), so that

$$s_1^2 = \frac{1.02956}{4-2} = 0.514781$$
and $s_2^2 = 0.98110$.

The estimates of the standard deviations of the intercepts are given by

$$s_b = \sqrt{\frac{s^2 \Sigma X^2}{N\Sigma X^2 - (\Sigma X)^2}}$$ so that,

$$s_{b_1} = \sqrt{\frac{0.514781(24.3678)}{4(24.2678) - (9.58)^2}}$$

$= 1.4842$, and
$s_{b_2} = 2.0764$

Carrying 6 digits as above is recommended, but 4 digits will suffice for most work.

As is usual, a "t" test may be made on a quantity which is expressed as a ratio of the quantity to its standard deviation. The hypothesis is made that the intercepts are zero, and this hypothesis is tested by means of $t = b/sb$ with N-2 degrees of freedom. Thus $t_1 = 0.0425/1.4842 = 0.0286$ and $t_2 = -4.7416/2.0764 = -2.284$.

Referring to Table 2 it is found that t_2 is about at a 15% risk level, while t_1 is greater than 90% risk, so that neither intercept may be said to differ from zero with any reasonable degree of confidence. To reject the hypothesis that these intercepts are zero means that one is willing to be wrong 15 and 90% of the time that such decisions are made, respectively. This is rather comforting, as the majority, if not all, of the research people using this correlation paper draw their straight lines through the feed point.

The technique employed so far has been directed toward disproving the hypothesis that the intercepts of both lines were zero. In this particular case neither hypothesis could be rejected, but if only one of them had been rejected it would have been sufficient to prove the lines different. If both hypotheses had been rejected, additional formulas would be needed to prove the lines different. To do this, a pooled standard deviation may be calculated from:

$$s_p = \sqrt{\frac{s^2_{b_1}(N_1-2)+s^2_{b_2}(N_2-2)}{N_1+N_2-4}}$$

and then the difference in intercepts may be tested by $t = (b_1-b_2)/s_p$ with $N_1 + N_2 - 4$ degrees of freedom. Although this test is not necessary here, it will be made to illustrate the method.

$$s_p = \sqrt{\frac{2(2.202849)+2(4.311436)}{4+4-4}} = 1.8048$$

$$t = \frac{0.0425-(-4.7416)}{1.8048} = 2.6508 \text{ with 4 degrees of freedom,}$$

which is associated with a risk of slightly over 5% if it is declared that the intercepts are different. Thus if one is willing to be wrong 5% of the time that such decisions are made, these intercepts may be declared to be different.

D2—Are the Slopes Different?

Since the two lines have intercepts which are not distinguishable from zero without taking a risk greater than 5%, and since standard practice makes them go through the feed point, the slopes should be recalculated on the restricted basis using the formula of V-C-2-a. Where this is done $a_1 = -6.5876$ and $a_2 = -5.9452$. The line for the No. 1 catalyst is indistinguishable from the previously calculated line, but a new line is drawn for the No. 2 catalyst as shown on Figs. 2 and 3.

The hypothesis is set up that these two slopes came from the same population, and differ only by random sampling fluctuations. Again a pooled estimate of the standard deviation of the slopes is needed, and may be obtained from

$$s_p = \sqrt{\frac{\Sigma Y_1^2 - \frac{(\Sigma X_1 Y_1)^2}{\Sigma X_1^2} + \Sigma Y_2^2 - \frac{(\Sigma X_2 Y_2)^2}{\Sigma 2_2^2}}{N_1+N_2-4}}$$

with *both* lines through the origin.

With *neither* line through the origin use the formula for Σd^2 in the numerator for *each* line.

For the illustrative case of the two catalyst this becomes:

$$s_p = \sqrt{\frac{1058.25-\frac{(-160.506)^2}{24.3678}+1567.10-\frac{(-262.524)^2}{44.1805}}{4+4-4}} = 1.4309$$

The test formula is again Student's "t" or:

$$t = \frac{a_1-a_2}{s_p\sqrt{\frac{N_1}{N_1\Sigma X_1^2-(\Sigma X_1)^2}+\frac{N_2}{N_2\Sigma X_2^2-(\Sigma X_2)^2}}}$$

and for the illustrative case:

$$t = \frac{(-6.5876)-(5.9452)}{1.4309\sqrt{\frac{4}{4(24.3678)-(9.58)^2}+\frac{4}{4(44.1805)-(12.91)^2}}} = -0.4280.$$

Entering Table 2 with $N_1 + N_2 - 4 = 4$ degrees of freedom, it may be stated with something less than 70% risk that the two slopes are different.

In other words, calling the catalysts different will be wrong 70% of the time such decisions are made; hence the catalysts are not believed to be significantly different.

A word of caution needs to be inserted here about the uses of the formulas in these last two Sections (D1 and D2); the procedures are exact when there is error in Y only, but become, at best, approximations when both X and Y have errors associated with them.

In order to compensate for this, it is suggested that a lower risk level than ordinary be used, such as 1 instead of 5%, before declaring any difference significant.

D3—How Different Are They?

In the illustrative example employed in the two previous sections (D1 and D2), the two regression lines were not proved to be different at any acceptable level of risk. But, when two correlation lines are shown to be different, it would be desirable to determine how different they are. To illustrate a method of finding this difference, these same data will be used in the following general manner.

At the point (or points) of interest, 95 Research octane number in this case, determine the absolute difference between the yields as read (or calculated) from the two least squares lines. Determine the standard deviation for each slope and draw in "shadow" lines having slopes equal to a $\pm s_a$, the band between these "shadow" lines being the area of uncertainty. At 95 octane number read off (or calculate) the yield uncertainty for each line, and using the methods in the next section (Propagation of Error) calculate the yield difference error, reporting the result as $(Y_1—Y_2) \pm s_Y$.

The first step is to calculate the values of

$$s_a = \sqrt{\frac{N\left[\Sigma Y^2-\frac{(\Sigma XY)^2}{\Sigma X^2}\right]}{(N-2)\left[N\Sigma X^2-(\Sigma X)^2\right]}}$$

for the two catalysts with the lines through the origin (otherwise use Σd^2):

$$s_{a_1} = 0.6008;\ s_{a_2} = 1.1936$$

The "shadow" lines of interest are now $Y_1 = -5.9868X_1$ and $Y_2 = -7.1387X_2$ and it is seen that they make the two "shadows" overlap, as could be expected from the fact that the two lines are not significantly different. 95 octane number corresponds to 3.13 on the arbitrary scale, and this, when substituted in the equations of the lines and "shadows" gives $Y_1 = -20.619188$; $Y_2 = -18.608163$; "shadow" $Y_1 = -18.738684$; and "shadow" $Y_2 = -22.344131$.

The absolute difference in yield is $Y_1 - Y_2 = 2.011025$ and the $Y_1 - Y_1$ shadow is 1.880504, while $Y_2 - Y_2$ shadow is 3.735968. The error of the difference is

$$\sqrt{(1.880504)^2 + (3.735968)^2} = 4.183$$

so that the final result is 2.011 ± 4.183 again showing that the catalysts are not different.

If the two lines have different intercepts, a shift of origin on one line to the intercept of the other makes the above method applicable.

Propagation of Error

Most of the quantities of interest in a study are not directly observable. For example, on a pilot unit, the yield of gasoline may be calculated from a product yield and a distillation, both of which have errors associated with them. A weight balance has meter readings and gravities as the basic data, or tank gages and gravities, all of which involve errors of various sizes.

The problem is to determine the magnitude of an error in such calculated quantities when the elemental errors are known or can be estimated reasonably well.

For most purposes the following equations hold; although it has been stated on good authority that they are strictly valid only for an additive relation, at least one text book does not make this restriction. If Q is the calculated quantity and it is some simple function of several observed quantities whose standard deviation is known or estimated, the following holds:

$$Q = f(X, Y, Z, \ldots)$$

$$s_Q^2 = \left(\frac{\delta Q}{\delta X}\right)^2 s_X^2 + \left(\frac{\delta Q}{\delta Y}\right)^2 s_Y^2 + \left(\frac{\delta Q}{\delta Z}\right)^2 s_Z^2 + \ldots$$

To illustrate, suppose a material balance is being made around a distillation unit, and it is safe to assume no change in volume on mixing, so that the charge is equal to the sum of the products which consist of a bottoms, a sidestream, and an overhead. It is further assumed that the standard deviation of the charge is 45 bbls./hr. on a charge rate of 500 bbls./hr., the standard deviation of the bottoms is 30 bbls./hr. on 300 bbls./hr., and the sidestream standard deviation is 15 bbls./hr. on 100 bbls./hr. It is desired to calculate the quantity of overhead (which is gaseous) as equivalent liquid, and estimate the error of such a calculation:

$$Q = C - S - B = 500 - 100 - 300 = 100 \text{ b/h}$$

$$\frac{\delta Q}{\delta C} = 1 \qquad \frac{\delta Q}{\delta S} = -1 \qquad \frac{\delta Q}{\delta B} = -1$$

$$s_Q^2 = (1)^2(45)^2 + (-1)^2(30)^2 + (-1)^2(15)^2$$

$$s_Q^2 = 2025 + 900 + 225 = 3150$$

$$s_Q = \sqrt{3150} = 56.2$$

This means that roughly two-thirds of the time when the actual production is 100 bbls./hr., the calculated value will lie in the band from 43.8 bbls./hr. to 156.2 bbls./hr.

Now consider the case where this same tower is operating and a weight balance must be used. The charge gravity is 23° API with a standard deviation of 0.3° API, the bottoms are 10° API with a standard deviation of 0.5° API and the sidestream has a gravity of 17.8° API with a standard deviation of 0.4° API.

$$Q = CG_c - SG_s - BG_B$$

$$Q = 500 \times 42 \times 7.627 - 100 \times 42 \times 7.893 - 300 \times 42 \times 8.328$$
$$= 22{,}083.6 \text{ lbs.}$$

Here the errors in weight of charge, sidestream and bottoms must be considered separately, and then the error in the overhead calculated.

$$Q' = CG_c$$

$$\frac{\delta Q'}{\delta C} = G_c;\ \frac{\delta Q'}{\delta G_c} = C$$

$$s_{Q'}^2 = \left[(G_c)^2 \times (45)^2 + (C)^2(0.014)^2\right](42)^2$$

$$= \left[(7.627)^2(45)^2 + (500)^2(0.014)^2\right](1764)$$
$$= 207{,}879{,}525.8568$$

$$Q'' = SG_s$$

$$\frac{\delta Q''}{\delta S} = G_s;\ \frac{\delta Q''}{\delta G_s} = S$$

$$s_{Q''}^2 = \left[(7.893)^2(15)^2 + (100)^2(0.021)^2\right](1764)$$
$$= 24{,}734{,}430.5393$$

$$Q''' = BG_B$$

$$\frac{\delta Q'''}{\delta B} = G_B;\ \frac{\delta Q'''}{\delta G_B} = B$$

$$s_{Q'''}^2 = \left[(300)^2(0.029)^2 + (8.328)^2(30)\right](1764)$$
$$= 110{,}242{,}442.3184$$

$$Q = Q' - Q'' - Q'''$$

$$s_Q^2 = 207{,}879{,}525.8568 + 24{,}734{,}430.5393 + 110{,}242{,}442.3184$$

$$s_Q^2 = 342{,}856{,}398.7145 \qquad s_Q = 18{,}516.38$$

It is thus seen that the weight balance has practically no significance since the error is nearly as large as the calculated value. It may also be seen that the major sources of error that can be corrected are the charge volume and bottom volume errors, the gravity errors being entiely insignificant.

It might be argued that if the gravities have errors the (gravity x volume error)^2 term, which is the large factor in each expression, may be too large, as the tendency in taking gravities of viscous stocks is to get too low an API gravity, or too high a value for lbs./gal. This is true, but the gravity would have to be off so badly that the lbs./gal. would change by a factor of 10 to reduce s_Q by a factor of 10, and this is manifestly not possible.

The third, and final, installment in this article series, to be published in an early issue, will cover the last three statistical techniques and their application—the analysis of variance, Model 1; which curve fits the data best; and the standard error of estimate.

Petroleum Processing Special Section on . . .

19th

Mid-Year Meeting

AMERICAN

PETROLEUM INSTITUTE

Division of Refining

May 10-13, 1954

Rice Hotel, Houston, Texas

Here's What You'll Find in This Special API Section

THE special 24-page section which follows is devoted to the API Division of Refining—to give you a better idea of what the Division is doing, of the activities of its many committees and some of the special projects they carry on as a service to the industry, and of what you will hear discussed at the mid-year meeting in Houston this month. Here's what you'll find:

- **Message from John Newton,** vice president for refining and chairman of the General Committee of the Refining Division ..... this page
- **Complete Program**—A list of all the papers scheduled for each group session and the various committee meetings. You will also find two helpful guides: 1) a "time-table" which tells what's happening, at what time, on what day, and where; and 2) an alphabetical list of committee meetings (by subject) with chairmen's names, time, date, and location ..... p. 705
- **Special Project Reports**—Detailed information on specific projects of the Refining Division:
  - 1—Corrosion ..... p. 708
  - 2—Tank Failures ..... p. 709
  - 3—Welding Research ..... p. 711
  - 4—Training Library ..... p. 712
  - 5—Committee Activities Summary p. 714
- **Committee Reports**—The annual reports by the seven technical committee chairmen of what their groups are doing and what they accomplished in 1953 ..... p. 715
- **Analytical Research**—A complete set of abstracts of the 18 papers to be presented at the two group sessions on this subject ..... p. 725

JOHN W. NEWTON
Vice President for Refining

WILLIAM T. GUNN
Director, Refining Division

The API Is "People"

THE Division of Refining of the API is far more than a mass of committees, important though these are in any organization.

The work of the Division is actually the total of all the effort expended by the men of the oil industry. For them, the Division is a forum in which they can discuss those technical facts and opinions that affect the industry's progress but not the vitality of its competition.

Not committees, not a company or group of companies, not the Division itself, but people form the prime mover. The lone individual in his laboratory, at his desk, in the field, who pries into the unexpected or hunts for a door in the wall of knowledge—he is the industry and, in a very real sense, the API.

Our people work voluntarily with the belief that rapid spreading of information, coupled with competition, has helped make us great and will make us greater. They make room on crowded schedules for the extra task. They are encouraged by the managements of hundreds of companies, big and little, who recognize the value of contributing toward that over-all body of technological knowledge from which their individual companies can fashion their own improvements.

So, as one who believes in the purpose of the API and in its merit, I salute all those other "ones" who, on their own, work on committees, prepare their papers, and do all the other tasks that must be done.

The people of the industry are truly great people.

J. W. Newton

J. W. NEWTON
API Vice President for Refining

API Division of Refining

• What's on the mid-year meeting program

PETROLEUM processing technologists and executives from all over the country will assemble in Houston, Texas, in a few days for the 19th mid-year meeting of the American Petroleum Institute's Division of Refining. The meeting will take place at the Rice Hotel, Monday through Thursday, May 10-13.

A total of 52 technical papers will be given during the 12 group sessions. In addition, a panel discussion has been scheduled on the subject: "Planning for Major Unit Turnarounds," as part of the two sessions on refinery maintenance.

Reports of the results of studies on two important refining problems are included among the technical papers. One is a report on the results of the survey of the study group on oil-storage tank failures, to be given by Carl H. Samans, Standard Oil Co. (Indiana), chairman of the study group.

The other is a status report on the research program of the Smoke and Fumes Committee, to be given by Vance N. Jenkins, Union Oil Co. of California, executive secretary of the committee.

A current controversial problem with widespread interest among all refiners—motor fuel and preignition—is also the subject of one session.

Another subject of wide general interest—petrochemicals—will be covered by four technical papers by authors from Standard Oil Co. (Ohio), Standard Oil Development Co., Continental Oil Co., and Gulf Oil Corp.

ANALYTICAL RESEARCH

Monday, May 10, 9:00 a.m., Ball Room.
Presiding: C. E. Headington, Atlantic Refining Co. (Session developed by Mr. Headington).

Coordinating the Operations of a Petroleum-Research Analytical Group, W. C. Schaefermeyer and E. S. Smith, Union Oil Co. of California.

A Simplified Amperometric Method for Determining Mercaptan Sulfur in Liquid and Gaseous Hydrocarbons, M. D. Grimes, J. E. Puckett, B. J. Newby, and B. J. Heinrich, Phillips Petroleum Co.

Analytical Distillation in Miniature Columns—I: Equipment and Operation, J. C. Winters and R. A. Dinerstein, Standard Oil Co. (Indiana).

New Techniques for Analyzing Mixtures of Trace Metals, R. M. Sherwood and F. W. Chapman, Jr., Atlantic Refining Co.

An Analyzer-Recorder for Measuring Hydrogen Sulfide in Air, E. B. Offutt, American Thermometer Division of Robertshaw-Fulton Controls Co., and L. V. Sorg, Standard Oil Co. (Indiana).

Micro Distillation Methods for the Analysis of Petroleum, A. R. Javes, C. Liddell, and W. H. Thomas, Anglo-Iranian Oil Co., Ltd.

A Reduced-Scale Reid Vapor Pressure Apparatus, R. L. LeTourneau, Julian F. Johnson, and W. H. Ellis, California Research Corp.

The Determination of Water in Acetaldehyde by Infrared Spectroscopy, J. A. Favre, J. P. Butler, and B. J. Heinrich, Phillips Petroleum Co.

CORROSION

Monday, May 10, 9:00 a.m., South American Room 1.
Presiding: L. W. Robbie, Republic Oil Refining Co. (Session developed by C. F. Pogacar, Atlantic Refining Co.).

Corrosion and Prevention — Heat Exchangers in Cooling-Water Service, J. D. Munro, Standard Oil Development Co.

Selection of Paints and Application in Combatting Atmospheric Corrosion, F. T. Radecke, Shell Oil Co.

Hydrogen-Chloride Evolution from Crude Oils as a Function of Salt Concentration, G. J. Samuelson, Petrolite Corp.

ANALYTICAL RESEARCH

Monday, May 10, 2:00 p.m., South American Room 1.
Presiding: R. J. Askevold, Pure Oil Co. (Session developed by C. E. Headington, Atlantic Refining Co.).

Methods for the Determination of Tetraethyl lead in Gasoline—A Review, C. M. Cambrill and Sue A. Gendernalik, Ethyl Corp.

Determination of Phenyl alpha-naphthylamine (PAN) in New and Used Oils (A Colorimetric Method), W. S. Levine and W. A. Marshall, Socony-Vacuum Laboratories.

Spectrochemical Determination of Copper in Crankcase Drainings, C. R. Hodgkins and John Hansen, Esso Laboratories Research Division, Standard Oil Development Co.

The Determination of Trace Amounts of Iron, Nickel, and Vanadium on Catalysts by X-ray Fluorescence, G. V. Dyroff and P. Skiba, Esso Laboratories Research Division, Standard Oil Development Co.

Non-Metal Analysis of Micro Quantities of Solids by Means of the Emission Spectrum, E. L. Gunn, Humble Oil & Refining Co.

Spectrographic Method for Analyzing Lubricating Greases, C. W. Key and G. D. Hoggan, Richfield Oil Corp.

Spectrographic Analysis of Petroleum Products and Related Materials, L. L. Gent, C. P. Miller, and R. C. Pomatti, The Texas Co.

Application of the Logarithmic Sector to Quantitative Spectrographic Analysis of Petroleum-Ash Residues, E. B. Childs and J. A. Kanehann, Socony-Vacuum Laboratories.

TRAINING

Monday, May 10, 2:00 p.m., Ball Room.
Presiding: G. R. Bryant, The Texas Co. (Session developed by R. B. McHenry, Gulf Oil Corp.).

Basic Management Training for Hourly Employes, W. E. Bennett, Cities Service Refining Corp.

How to Train Your Subordinates, Richard E. Crow, Continental Oil Co.

How Far to Harmonious Relationships? L. R. Boulware, General Electric Co.

REFINERY MAINTENANCE

Tuesday, May 11, 9:00 a.m., Ball Room.
Presiding: Bonner H. Barnes, Gulf Oil Corp. (Session developed by H. W. Ferguson, Humble Oil & Refining Co.).

Minimizing the Refinery-Maintenance Crew, F. C. King, General Petroleum Corp.

Use of Technically Trained Men in Refinery-Maintenance Work, D. G. Debo and J. G. Housman, Standard Oil Co. (Indiana).

Correlation of Manpower Requirements, Maintenance Requirements, and Equipment Selection, Michael A. Pappas and James S. Dalton, Standard Oil Co. (Ohio).

Effective Control of Stores Operations, J. H. Anderson, Humble Oil & Refining Co.

REFINERY MAINTENANCE

Tuesday, May 11, 2:00 p.m., Ball Room.
Presiding: Clarence H. Thayer, Sun Oil Co. (Session developed by H. W. Ferguson, Humble Oil & Refining Co.).

The Area-Supervisor System as Applied to the Baton Rouge Refinery, O. R. Menton, Esso Standard Oil Co.

PANEL SESSION: Planning for Major-Unit Turnarounds; panel members: C. H. Trotter, Phillips Petroleum Co.; E. C. Newton, Atlantic Refining Co.; J. T. Tippit, The Texas Co., and A. C. Collins, Shell Oil Co.

OIL STORAGE TANK FAILURES

Tuesday, May 11, 7:00 p.m., Ball Room.
Presiding: R. G. Sanders, Magnolia Petroleum Co. (Session developed by Carl H. Samans, Standard Oil Co.—Indiana).

Brittle Failure of Steel Structures—A General Engineering Problem, Prof.

DATE	9:00 A.M.	2:00 P.M.
FRI. MAY 7	Corrosion Subcommittee, French Room	Corrosion Subcommittee, French Room
SAT. MAY 8	Analytical Research Comm., Hunt Room Corrosion Subcommittee, French Room Pressure-relieving Systems Subcomm., Room E	Analytical Research Comm., Hunt Room Corrosion Subcommittee, French Room Pressure-relieving Systems Subcomm., Room E
SUN. MAY 9	Joint Meeting: Mechanical Equipt. Subcomm. & Mfgrs. Centrifugal Pumps Subcomm., French Room Safety & Relief Valves Mfgrs. Subcomm., Hunt Room Joint Meeting: Inspection Supervisors Subcomm. & Designers' Subcomm. on Inspections, Jade Room Oil-Water Separation Subcomm., Room E (10:00 a.m.)	Joint Meeting: Mechanical Equipt. Subcomm. & Mfgrs. Centrifugal Pumps Subcomm., French Room Safety & Relief Valves Mfgrs. Subcomm., Hunt Room Joint Meeting: Inspection Supervisors Subcomm. & Designers' Subcomm. on Inspections, Jade Room Tank Accessories & Cleanouts Subcomm., Room E
MON. MAY 10	**Analytical Research Session, Ball Room** **Corrosion Session, So. American Room 1** Training Committee, Reception Room Valves, Mfgrs. Subcommittee, Hunt Room Joint Meeting: Low-Pressure Storage Tanks Subcomm. & Mfgrs. Subcomm. on Low-Pressure Storage Tanks, French Room Chemical Wastes Subcommittee, Room E Automotive Research Committee, Jade Room	**Analytical Research Session, So. American Room 1** **Training Session, Ball Room** Petroleum Products Committee, Jade Room Electrical Equipment Subcomm., Reception Room Corrosion Subcommittee, Hunt Room Waste Gases & Dusts Subcommittee, Room E Joint Meeting: Low-Pressure Storage Tanks Subcomm. & Mfgrs. Subcomm. on Low-Pressure Storage Tanks, French Room
TUES. MAY 11	**Refinery Maintenance Session, Ball Room** Analytical Research Committee, French Room Training Committee, Jade Room Smoke & Fumes Technical Advisory Comm., Room E Sampling & Testing Subcommittee, Hunt Room Sludges & Clays Subcommittee, Reception Room	**Refinery Maintenance Session, Ball Room** Analytical Research Committee, French Room Training Committee, Jade Room Sampling & Testing Subcommittee, Hunt Room Program Committee, Reception Room Pump Manuals Mfgrs. Subcommittee, Room E
WED. MAY 12	**Waste Disposal Session, So. American Room 1** **Motor Fuels Session, Ball Room (9:30 a.m.)** Analytical Research Committee, French Room Training Committee, Jade Room Advisory Committee, Room 336 Valves Subcommittee, Room E Unfired Pressure Vessels Subcommittee, Hunt Room Instruments Subcommittee, Western Room Electrical Equipment Subcommittee, Room 927	**Petrochemicals Session, Ball Room (2:30 p.m.)** Analytical Research Committee, French Room Training Committee, Jade Room General Committee, Reception Room (1:30 p.m.) Disposal of Refinery Wastes Committee, Hunt Room Refinery Equipment Committee, So. American Room A Joint Meeting: Pump Manuals Subcommittee & Mfgrs. Subcommittee, Room 336
THURS. MAY 13	**Processes Session, Ball Room** Disposal of Refinery Wastes Committee, Jade Room Refinery Equipment Committee, French Room Smoke & Fumes Committee, Hunt Room	**Fractionation Session, Ball Room** General Committee Meeting, So. American Room A (1:30 p.m.)

TUES. MAY 11 AT 7:00 P.M.	**Oil-Storage Tank Failures Session, Ball Room**	**Heavy Type—Group Sessions**
WED. MAY 12 AT 7:00 P.M.	**Open Dinner Session, Ball Room**	Light Type—Committee Meetings
THURS. MAY 13 AT NOON	General Committee Luncheon, So. American Room 1	

M. E. Shank, Massachusetts Institute of Technology.

Results of the Survey of the Study Group on Oil Storage-Tank Failures, reporting for the members of the Study Group: Carl H. Samans (chairman), Standard Oil Co. (Indiana).

Some Economic Aspects of the Oil Storage-Tank Failure Problem, F. A. Gitzendanner, Standard Oil Co. (Indiana).

The Standard Oil Development Co. Study of Brittle Failure of Tank Steels, F. J. Feely, Jr., and M. S. Northup, Standard Oil Development Co.

WASTE DISPOSAL

Wednesday, May 12, 9:00 a.m., South American Room 1.

Presiding: C. C. Tate, Phillips Petroleum Co. (Session developed by W. C. Douce, Phillips Petroleum Co.).

New Oil-Reclamation and Waste-Disposal Facilities, W. L. Pursell and T. W. Ferguson, Skelly Oil Co.

Preferential Withdrawal of Catalyst Fines to Reduce FCC Stack Losses, C. A. Seibert, Jr., and D. L. Cleveland, Shell Oil Co.

New Developments in the Disposal of Refinery Waste Gases, D. B. Ardern, Houdry Process Corp., and Raymond C. Lassiatt, Sun Oil Co.

Chemical Flocculation of Refinery Wastes, R. F. Weston, Atlantic Refining Co.

Planning and Execution of a Refinery Waste-Stream Survey, A. P. Dennis, Jr., Esso Standard Oil Co.

Status Report on the Research Program of the Smoke and Fumes Committee, Vance N. Jenkins, Union Oil Co. of California (executive secretary, API Smoke and Fumes Committee).

MOTOR FUELS

Wednesday, May 12, 9:30 a.m., Ball Room.

Presiding: Bruce K. Brown, Pan-Am Southern Corp. (Session developed by F. J. Sanders, Standard Oil Co.—Ohio).

The Contribution of Surface Combustion of the Fuel to Preignition, R. E. Wilson, F. W. Bowditch, and G. J. Nebel, General Motors Research Laboratories.

The Preignition Resistance of Fuels, B. M. Sturgis, E. N. Cantwell, W. E. Morris, and D. L. Schultz, E. I. du Pont de Nemours & Co., Inc.

The Study of Fuel Additives to Reduce Preignition, F. C. Burk, L. J. Test, and H. R. Jackson, Atlantic Refining Co.

The Measurement and Chemical Control of Preignition in Engines, J. B. Hinkamp, H. A. Toulmin, Jr., and J. S. Wintringham, Ethyl Corp.

PETROCHEMICALS

Wednesday, May 12, 2:30 p.m., Ball Room.

Presiding: Harold G. Osborn, Continental

● Here's a Guide to Help You Find Committee Meetings . . .

Subject	Chairman	Date	Time*	Place
Advisory Committee	E. B. McConnell	Wed., May 12	9:00 a.m.	Room 336
Analytical Research Committee	C. E. Headington	Sat., May 8	9:00 a.m.	Hunt Room
	C. E. Headington	Tues., May 11	9:00 a.m.	French Room
	C. E. Headington	Wed., May 12	9:00 a.m.	French Room
Automotive Research Committee	C. E. Davis	Mon., May 10	9:00 a.m.	Jade Room
Chemical Wastes Subcommittee	R. J. Austin	Mon., May 10	9:00 a.m.	Room E
Corrosion Subcommittee	H. G. Mangelsdorf	Fri., May 7	9:00 a.m.	French Room
	H. G. Mangelsdorf	Sat., May 8	9:00 a.m.	French Room
	H. G. Mangelsdorf	Mon., May 10	2:00 p.m.	Hunt Room
Disposal of Refinery Wastes Committee	J. H. Easthagen	Wed., May 12	2:00 p.m.	Hunt Room
	J. H. Easthagen	Thurs., May 13	9:00 a.m.	Jade Room
Electrical Equipment Subcommittee	L. M. Goldsmith	Mon., May 10	2:00 p.m.	Reception Room
	L. M. Goldsmith	Wed., May 12	9:00 a.m.	Room 927
General Committee	J. W. Newton	Wed., May 12	1:30 p.m.	Reception Room
	J. W. Newton	Thurs., May 13	12:00 noon	So. American Room 1
	J. W. Newton	Thurs., May 13	1:30 p.m.	So. American Room A
Inspection Supervisors Subcommittee, joint with: Inspections, Designers' Subcommittee	W. K. Brown / J. H. Rickerman	Sun., May 9	9:00 a.m.	Jade Room
Instruments Subcommittee	G. N. Ehly	Wed., May 12	9:00 a.m.	Western Room
Low-Pressure Storage Tanks Subcommittee: joint with: Low-Pressure Storage Tanks Mfgrs. Subcommittee	W. L. Bowler / H. C. Boardman	Mon., May 10	9:00 a.m.	French Room
Mechanical Equipment Subcomm. (joint with Mfgrs. Subcomm. on Centrifugal Pumps)	E. F. Voss	Sun., May 9	9:00 a.m.	French Room
Oil-Water Separation Subcommittee	R. C. Adam	Sun., May 9	10:00 a.m.	Room E
Petroleum Products Committee	R. C. Alden	Mon., May 10	2:00 p.m.	Jade Room
Pressure-relieving Systems Subcommittee	J. C. Souder	Sat., May 8	9:00 a.m.	Room E
Program Committee	C. M. Ridgway	Tues., May 11	2:00 p.m.	Reception Room
Pump Manuals Mfgrs. Subcommittee	G. V. Shaw	Tues., May 11	2:00 p.m.	Room E
Pump Manuals, Mfgrs. Subcommittee joint with: Pump Manuals Subcommittee	G. V. Shaw / J. J. Stadtherr	Wed., May 12	2:00 p.m.	Room 336
Pumps, Centrifugal, Mfgrs. Subcommittee (joint with Mechanical Equipment Subcommittee)	Lynn Sawyer	Sun., May 9	9:00 a.m.	French Room
Refinery Equipment Committee	R. H. Venn	Wed., May 12	2:00 p.m.	So. American Room A
	R. H. Venn	Thurs., May 13	9:00 a.m.	French Room
Safety & Relief Valves, Mfgrs. Subcommittee	L. P. Stillman	Sun., May 9	9:00 a.m.	Hunt Room
Sampling & Testing Subcommittee	L. Mittelman	Tues., May 11	9:00 a.m.	Hunt Room
Sludges & Clays Subcommittee	J. A. Fowler	Tues., May 11	9:00 a.m.	Reception Room
Smoke and Fumes Committee	W. L. Stewart, Jr.	Thurs., May 13	9:00 a.m.	Hunt Room
Smoke and Fumes Technical Advisory Committee	H. G. Vesper	Tues., May 11	2:00 p.m.	Room E
Tank Accessories & Cleanouts Subcommittee	E. E. Kerns	Sun., May 9	2:00 a.m.	Room E
Training Committee	D. S. Turner	Mon., May 10	9:00 a.m.	Reception Room
	D. S. Turner	Tues., May 11	9:00 a.m.	Jade Room
	D. S. Turner	Wed., May 12	9:00 a.m.	Jade Room
Unfired Pressure Vessels Subcommittee	N. J. Rees	Wed., May 12	9:00 a.m.	Hunt Room
Valves, Mfgrs. Subcommittee	W. P. Kliment	Mon., May 10	9:00 a.m.	Hunt Room
Valves Subcommittee	R. H. Bungay	Wed., May 12	9:00 a.m.	Room E
Waste Gases & Dusts Subcommittee	W. C. Douce	Mon., May 10	2:00 p.m.	Room E

* Times shown are starting times: some meetings run all day.

Oil Co. (Session developed by L. O. Crockett, Gulf Oil Corp.).

Petrochemicals—Glamour Girl or Problem Child? G. B. Ryan and V. A. Brietenbach, Standard Oil Co. (Ohio), and H. K. Nieuwenhius, consultant, New York City.

Isobutylene Manufacture Using the Sulfuric-Acid Process, G. P. Baumann and M. R. Smith, Standard Oil Development Co.

Simultaneous Extraction of Benzene and Toluene by the Sulfur-Dioxide Process, R. A. Ratliff and W. B. Strobel, Continental Oil Co.

Large-Scale Manufacture and Distribution of Ethylene, P. W. Cornell, W. H. Litchfield, and H. M. Vaughan, Gulf Oil Corp.

OPEN DINNER SESSION

Wednesday, May 12, 7:00 p.m., Ball Room.

Presiding: John W. Newton, Magnolia Petroleum Co., and Vice-President for Refining, American Petroleum Institute. (Session developed by H. D. Wilde, Humble Oil & Refining Co.).

Opening Remarks, John W. Newton, Vice-President for Refining.

Recognition of Executive Ability in Yourself and Others, Robert F. Pearse, Worthington Associates, Chicago.

PROCESSES

Thursday, May 13, 9:00 a.m., Ball Room.

Presiding: H. D. Wilde, Humble Oil & Refining Co. (Session developed by F. W. Schumacher, Standard Oil Development Co.).

Dualayer Distillate Fuel-Oil Treating Process, C. A. Duval, R. T. Malin, and V. A. Kalichevsky, Magnolia Petroleum Co.

Factors in Selecting a Catalytic Reforming Process, J. A. Boch, W. R. Hertwig, L. W. Russum, and R. A. Steel, Standard Oil Co. (Indiana).

A Model II Fluid Hydroformer and Its Application, E. W. Nicholson, Esso Standard Oil Co.

Hyperforming, Clyde Berg, Union Oil Co. of California.

FRACTIONATION

Thursday, May 13, 2:00 p.m., Ball Room.

Presiding: C. P. Baker, Socony-Vacuum Oil Co., Inc. (Session developed by R. C. Adam, Magnolia Petroleum Co.).

Fractionation-Equipment Sizes for Refinery Feed Stocks, G. T. Atkins and G. W. Wilson, Humble Oil & Refining Co.

Effective Use of the Fractionating Ability of Continuous-Distillation Columns, Norman Kirk, General Electric Research Laboratory, and Merrell R. Fenske, The Pennsylvania State College.

The Performance of Catalytic Cracking-Unit Fractionating Towers, G. S. Houghland, E. J. Lemieux, and W. C. Schreiner, M. W. Kellogg Co.

Hydraulics of Tray Design, Prof. R. L. Huntingdon, University of Oklahoma.

OVERALL AND PER-BARREL REFINING CORROSION COSTS

Cost Factor	Per Bbl. Crude Run	Industry Total, Approx.
1—Anti-Corrosion Built-In	$0.021	$50,000,000
2—Maintenance	0.071	168,000,000
3—Lost Production on Scheduled Shutdowns	0.018	43,000,000
4—Tool Stocks, Inventory	0.0025	6,000,000
	$0.1125	$267,000,000

In the table at the left, it assumed that 2,370,400,000 bbl. of crude were charged to stills in 344 days during 1951, a total of 21 days being allowed for scheduled shutdowns.

On the basis of $0.1125 per bbl., the actual total loss would be $267,000,000. The figure of $270,000,000 was taken as an approximation of the total refining industry loss.

This method was used by the API panel for estimating overall refining industry costs, and is tentatively proposed as a standard.

Measuring Plant Corrosion Costs

New technique for analyzing costs proposed by API Refining Division's cost study group

By V. B. GUTHRIE
Associate Editor

TWO part-way goals have been reached in the program of the API Refining Division for developing means to help oil companies reduce the present high corrosion costs encountered in processing petroleum.

1—An estimate has been worked out of the yearly direct cost to the refining industry of combating the deterioration of metals through corrosion occurring in their plants. This approximation is $270,000,000, or $0.1125 per barrel of crude run to stills (see table above).

2—The methods of analysis used by an API cost study panel in setting up this overall industry figure have been proposed for use by oil companies and plants in setting up their own individual corrosion costs.

Although the estimate for the industry and the methods used in setting it up are tentative; refining companies representing nearly 70% of the crude charged to stills in this country agree in general with the panel's work.

What has been accomplished so far is only the first phase of the API program. Having established the extent of the overall corrosion cost, and suggested a means for individual companies to approximate their own costs, it is proposed to show how these expenses in refining can be reduced 15-20% by greater application of the present known methods for corrosion protection. It is also planned to develop new techniques for protection.

The API program is under the direction of a Subcommittee on Corrosion of the Committee on Refinery Equipment of the Refining Division. E. Q. Camp, Houston, Humble Oil and Refining Co., is chairman of the subcommittee. The corrosion cost studies have been carried on by a panel of the subcommittee, of which F. C. Braun, Pittsburgh, Gulf Oil Corp., is chairman.

The cost studies were started in 1953 and it was then thought that $200,000,000 would be a high corrosion cost for the refining industry. As data was gathered from the oil companies and better methods of cost estimation were developed, the higher the overall figure has gone.

Members of the panel believe the present per-barrel cost figure ($0.1125) for the corrosion cost for the industry is considerably under the actual cost for some individual plants where corrosive crudes are being processed.

The present tentative technique for corrosion cost estimation is to a considerable extent based on actual cost figures for building and maintaining processing units. The direct corrosion costs are considered to be of four types: (1) Built-in, anti-corrosion costs for processing units; (2) maintenance costs chargeable to corrosion; (3) costs of loss in production due to corrosion, at regular shutdowns; (4) costs of special tools and labor required for corrosion repairs, and interest on money tied up in replacements and inventory because of corrosion.

Following is a discussion of the panel's tentatively proposed technique for estimating direct corrosion costs and also summaries of comment from oil companies to whom the panel's data was submitted.

1—Built-In Corrosion Protection

In order to determine the cost level of corrosion-suppressing equipment originally built into an average manufacturing unit designed for a crude oil of average corrosivity, a 32,000 bsd atmospheric crude still and outlying appurtenances was selected for analysis.

The unit selected was designed with a normal amount of anti-corrosion material in heaters, vessels and lines to withstand a crude of average corrosivity. Cost data covered the still proper, additional steam and electrical utilities, cooling tower and water facilities, field oil lines and running and storage tanks required for the unit.

Cost records and design drawings were used in estimating total anti-corrosion investment in fired heaters; towers, drums and storage tanks; heat exchangers; pumps, compressors and drivers; piping (alloy and carbon steel); structural steel; painting, etc.

At the same time, an estimate of useful life, converted to dollars cost per year, was made for anti-corrosion material, and corrosion allowance in each category.

On the 32,000-bbl. unit and outlying accessories, the anti-corrosion investment was estimated as 13% of the total cost of the complete job. The equivalent life of the built-in, anti-corrosion investment, weighted on the the basis of cost per year, was taken as 7 years. The factor for converting 1947 construction and materials costs to a 1953 basis was taken as 1.35. The originally built-in investment cost to the company was based on the concept of capital recovery (earning power interest compounded annually).

From the study of these factors, the unit cost of the originally built-in anti-corrosion investment was set at $0.021 per bbl. of crude processed. On the volume of 2,370,400,000 barrels processed in 344 days in 1951 (see table), the total annual cost to the refining industry was estimated at approximately $50,000,000.

The per barrel estimate resulting from the detailed investigation of the actual costs of the 32,000-bbl. atmospheric-vacuum crude unit, to the panel's surprise, tallied closely with the theoretical estimate of this corrosion cost factor which the committee had made earlier.

The oil companies to whom the API corrosion cost data has been submitted, have suggested from their experience that the factor of 13% of the cost of the total job as representing the cost of originally built-in anti-corrosion equipment, is too high. They expressed a preference for a 10-13% factor.

Information received was not specific enough, the panel stated, to warrant changing the 7-year average life figure for built-in equipment. One company thinks the estimate is too low. The replies varied considerably on the figure of $0.021 as the per-barrel corrosion cost for built-in protection. The range was from 50 to 300% of the committee's estimate.

This variance was believed to come about through a difference in the processing units studied by the reporting oil companies, in their estimates of useful life, and natural differences in the methods of analyzing cost data.

2—Maintenance Costs Chargeable to Corrosion

Investigations of maintenance costs made independently by two large refineries, showed 70 and 73% chargeable to corrosion. For each refinery, on a per barrel basis, the maintenance cost due to corrosion was $0.071.

Comment from oil companies on this factor in refinery corrosion costs showed a spread of from 50 to 90% in the percentage of maintenance cost chargeable to corrosion. The estimate of 70 to 73% used by the panel in setting up its tentative corrosion yardstick for refineries, is to be continued as a satisfactory base until more detailed maintenance cost accounting is available.

The unit maintenance cost of $0.071 per bbl. tentatively set up, is considered an acceptable figure, in view of the range of 7 to 11 cents a barrel given in the comment from oil companies.

3—Lost Production Due to Corrosion

This corrosion cost factor includes inspection, special maintenance, and interest on money tied up in replacements and inventory.

In setting up the $0.018 cost per barrel of this factor, the API group assumed that an average processing unit has three weeks of scheduled shutdown per year, and that an average of five days of this period are required for corrosion tasks, such as inspections and calibration of metal thickness.

On the basis of 1951 operations, if the five days of shutdown due to corrosion could have been avoided, an additional 34,500,000 barrels of crude would have been processed. It is further assumed that processing operations increase the value of each barrel of crude by $1.25. Thus $43,000,000 a year is lost to the oil companies because of corrosion tasks on scheduled shutdowns, or $0.018 per barrel of the total 2,347,400,000 barrels of crude charged.

Replies from the oil companies were not clearly drawn on this corrosion item. One suggested an estimate of $0.0125 per bbl.

4—Tool Stocks and Inventories

Corrosion factors here are (a) costs of tool stocks used for corrosion inspection and maintenance, and field operators and users of these tools, and (b) interest on money tied up in replacement and inventory because of corrosion. It was assumed that costs in both cases are $6,000,000 per year for the industry, and the per barrel cost was $0.0025.

Indirect Corrosion Costs

These result from such causes as accident and fire losses, lost production on unscheduled shutdowns, evaporation through deteriorated tank roofs, leaks through openings caused by corrosion, above-normal insurance rates, civic responsibilities in regard to stream pollution where corrosion is a factor, and others.

The panel as yet has found no way to approximate the indirect corrosion costs, except possibly as a percentage of direct cost. It has asked the oil companies to submit suggestions on this point.

Summary of Cost Work

Opinion in the refining industry, the API Subcommittee on Corrosion Costs believes, is in favor of the method of cost estimation represented in the present tentative schedule. Said one member, "It may be that approval so far has stemmed from the fact that companies not represented on the committee have not yet set to work to analyze their own costs on this same basis. The one detailed reply received followed the pattern fairly well, the differences in results stemming from differences in methods of analysis and estimation.

"While there is no cut-and-dried answer, the subcommittee feels it has already accomplished one valuable result in revealing a considerable overall corrosion cost in the refining industry, the approximate level of which is at least logical and has been of great interest to the oil companies.

"With such an awakening of interest at the management level, as is evidenced by statements that maintenance costs attributable to corrosion will be isolated in the future, the subcommittee feels that the first phase of the API Corrosion Protection Program is reaching a conclusion.

"The next phase should be a review of corrosion costs to determine to what extent they may be controlled on the basis of the refineries' experience with corrosion protection methods."

Report on Tank Failures

THE first public report on the problem of oil storage tank failures will be made at the Houston meeting of the API Refining Division at a group session, Tuesday evening, May 11.

Four aspects of the problem to be covered in as many papers are:

1—A broad historical survey of failures of this type.

2 — The extent of the problem throughout the refining industry, the results of a survey on large oil storage tank failures made by the special Study

Committee appointed to the task by the Committee on Refining Equipment.

3—The cost figures which must be kept in mind in looking at the results of the special Study Committee survey.

4—Latest results in an experimental study of ways for decreasing further the chance of brittle failure of steel as built into an API standard oil storage tank.

The reports presented are fact finding. Later on, recommendations will be made to the Committee on Refinery Equipment, after due consideration has been given by all concerned to the facts available.

That the problem is not new will be brought out in a paper reviewing past history, by M. E. Shank, Massachusetts Institute of Technology. Such failures have been occurring from time to time, usually with little or no warning, ever since steel has been used for engineering structures, a period of about 75 years, according to Dr. Shank.

Several of the more striking failures of this type will be described. Generally, several factors, some not clearly known even now, have been needed to explain some of these failures. These factors vary, and not always the same ones seem to be most important in the different cases. The problem is particularly puzzling because, in most cases, the cracks look as though the steel was extremely brittle. However, the usual tests all show the steel to have its -normal good engineering properties; and designing has been done on that basis.

The loss of about 250 welded steel ships in a similar manner of failure, and the cracking in service of about 1200 more during the period 1942-52 focussed a great deal of attention on the problem, and some of the world's outstanding scientists and engineers have studied it with only moderate success towards solving it. Dr. Shank points out that tests of samples show that the steel only acts as though it were brittle when it is cooled below some critical temperature, and that this seems to be different for each plate. The age of the structure or of the steel is not important.

When a crack occurs in the steel, under tensile loading, it progresses nearly with the speed of sound in steel. Although many seem to think that welded structures are more apt to crack than do riveted structures, there is no real evidence to support this view. In fact, cracks usually run through the parent steel rather than along the welded seams. However, defects of design or due to fabrication procedure usually are important, although sometimes these details are so small that they cannot readily be found.

Over the years, the ingenuity of engineers and the experience they have gained from earlier failures have led to many methods for lessening the major causes of cracking in steel structures. In general, as long as the recommendations of existing design standards are followed, the chance of failure probably is small. However, as long as, in any failure, we know neither all of the factors involved nor their relative importance, there always will be some chance of failure occurring, no matter how small.

The extent of failures in the refining industry will be indicated by the report of the chairman of the special Study Committee, Dr. Carl H. Samans, associate director of engineering research for Standard Oil Co. (Indiana).

There are about 6000 large tanks in service today, each of which can hold 55,000 bbl. or more. There have been 32 failures in the past 35 years of such tanks in this country. They have failed either partially, by a crack or split of limited extent, or completely.

Although there have been over twice as many partial failures as complete failures, there is no reason to think that any of the partial failures would not have been complete if conditions had been as adverse as they might have been. No way of predicting whether or not a failure might occur is known. Some of the tanks failed when first filled. Others gave satisfactory service for as long as forty years before anything happened. Still others, after failing partially relatively early in their life, were repaired and then have given over twenty years of service without any further trouble.

Cases also are known in which fairly large partial cracks must have existed partway through the tank wall for a sizable time before a number of new and different adverse factors happened to coincide, and a crack to failure appeared. Oil storage tanks, like all other structures, are built with plenty of extra material in their wall thickness, and it takes some unexpected and powerful forces really to harm them.

The economic slant to these failures will be explained by Fred A. Gitzendanner, also an associate director engineering research for Indiana Standard.

He will point out that the loss from a single tank failure has ranged from about $5000—when only minor repairs were made and most of the tank's contents recovered—to as much as $500,000—when there was a complete loss of tank and contents.

The average loss was $90,000 per failure. On this basis, an annual insurance premium of $60 per tank could cover the risk for this type of sudden tank failures. Actually, this figure is low when compared to the corresponding fire insurance premium of $220 per tank per year on the average being paid by refiners.

Mr. Gitzendanner also will discuss the relative costs of other things that might be done to decrease the chance of such failures, and show how all of them have to be looked at as a calculated risk, as against the soundness and cost of the methods proposed for reducing failures.

New methods to decrease the chances of brittle failure will be described by Frank J. Feely, Jr., and Maynard S. Northup, Standard Oil Development Co. In their special test, the latest and most promising approach to the problem, pieces of steel plate up to 16 ft. long and 40 in. wide are being tested in a manner approaching service conditions more closely than is possible with the customary small test pieces.

Cracks of known length, and varying degrees of fineness that are almost impossible to see even under a microscope, down to those produced at liquid nitrogen temperature, are first produced by a specially controlled method.

The specimen next is cooled to the desired test temperature and is stretched by a known load. A gun is then used to drive a wedge into the crack very rapidly. If the temperature is too high, or if the stretching load is too small, either nothing will happen or the crack will lengthen a small amount only. However, if the temperature is low enough and the stretching load is high enough the crack will jump very rapidly entirely across the test plate.

The effects of such factors are being studied as width of test pieces, their length and thickness, the size of the initial (made) crack, the test temperature, and the type of steel. Although, in this special test method, the ordinary carbon steels that are now made for the shipbuilding industry seem to give uniform results, those made for general structural purposes, including the usual tank steels, vary a great deal. Some plates will resist cracking, even when the temperatures are relatively low and the stretching loads are relatively high; others bought to the same specification will crack readily even when the temperatures are relatively high and the stretching loads are relatively low. Thus far the reasons for these differences are not known, and no other simpler test has been found which shows them so clearly.

More Economic Pressure Vessels

That is goal of engineering research studies to which API gives considerable financial aid

By WILLIAM C. UHL
Associate Editor—Equipment

THE petroleum processing industries today spend an estimated 15 to 20% of the new construction dollar every year for pressure vessels. Based on last year's total capital investment by refiners of some $1,056,250,000, this means that pressure vessels are probably costing the refiner around $150,000,000 to $200,000,000 annually.

An important current research activity is directed at an ultimate goal of reducing some of this cost—through more careful design, more efficient use of the newer metals, and at higher design stresses and an increase in the true factor of safety.

This activity is receiving considerable financial support by the American Petroleum Institute as well as active participation by interested API members. It is being conducted by the Pressure Vessel Research Committee of the Welding Research Council and has received API support since its inception in 1945. PVRC operates on an approximate annual budget of $80,000, of which the API contributes about one-third.

Including this direct support of pressure vessel research, API is responsible for 12% of the cost of all research projects conducted by the Welding Research Council itself.

As pointed out by PVRC Chairman Perry R. Cassidy, of Babcock & Wilcox Co., "A 1% reduction in the cost of pressure vessels will represent savings equal to many times the total cost of the research program to date."

Principal goal of the PVRC work is to arrive at factual data needed by code making groups, by designers in the manufacturing field, and by all other engineers who are concerned with the design of pressure vessels, using the newer, higher strength steels.

These steels, ranging in yield strength from 70,000 to 90,000 psi. and in tensile strength from 100,000 to 120,000 psi., cannot be used economically today, because of certain restrictions in stress allowances. PVRC proposes to show that higher strength steels are not susceptible to failure any more than the medium strength steels presently employed in pressure vessel construction, but may be used—safely and economically—with much higher design stresses, under certain limitations of service.

Organization of PVRC itself was at the original request of the Boiler Code Committee and the Welding Research Council. The main committee comprises about 100 engineers and technologists from such segments of industry as steel makers, fabricators, boiler and vessel builders, engineering construction firms, the petroleum and chemical industry, as well as research organizations, universities, government agencies, and associations who are concerned with the problem—like the API.

Three principal divisions make up the group—materials, design, and fabrication. In addition, there are a number of important subcommittees directly concerned with specific projects. These include: research on high-strength steels, stress corrosion cracking, inspection and testing, tests on low-alloy high-strength steels in pressure vessels, materials for high-temperature service, increased design stresses, and many others.

Some 40 reports have already been published by PVRC, reflecting the results of work and projects carried out by the various subcommittees.

Information already available to industry, through these published reports, includes:

1—Effects of different deoxidation practices on the behavior of steels.

2—Deleterious effects of the straining of steels associated with temperature or time, and how these effects may be overcome.

3—The manner in which steels which are ductile at ordinary room temperatures become brittle at low temperatures.

4—How brittle failure may be avoided by the selection of suitable steels, together with utilizing better design and workmanship.

5—Heat treatment effects covering preheating of vessels before welding.

6—Amelioration treatments by post-heating.

7—The influence of corrosive environments on cracking of steel and how they may be controlled.

8—Proof testing of vessels.

9—The possible use of carbon steel plates of structural quality in pressure vessels during times of material shortages.

Information now being developed in current projects will augment the data already accumulated to prove out the major premise of the PVRC goal—that pressure vessels can, and must eventually, be made at lower cost yet with increased strength and safety.

Among them are many projects of considerable significance to the petroleum processing industries, while all of them are of high value to pressure vessel users and builders. For example:

The Fabrication Division is sponsoring, among others, three closely correlated projects concerned with the mechanical properties of high tensile steels which are being considered for use in pressure vessels in order to permit higher design stresses.

The Design Division's work has resulted in two reports soon to be published, which are seen as important and helpful contributions to the problems caused by local loads on vessels applied through nozzles, lugs, clips, supports, etc. Analytical and experimental data has been, up to this time, extremely scarce and entirely inadequate for this type of loading to which vessels are regularly subjected in service.

Another project being considered is aimed at developing design rules for size, location, buckling strength, circularity, etc., of the reinforcement at the intersection of conical and cylindrical shells.

The Materials Division likewise is contributing much to the overall goals of PVRC. Among projects of interest to the petroleum processor are: 1) a research investigation of stress corrosion cracking, and 2) compilation of the basic properties of six high tensile steels.

The stress corrosion cracking project has been assigned to the National Bureau of Standards. The first part of the program is to devise an accelerated laboratory test to obtain satisfactorily reproducible results—in 250 hours or less—of the transcrystalline stress-corrosion cracking of Type 304 stainless steels. The overall problem is to determine the conditions under which austenitic stainless steels are subject to this phenomenon.

Do You Need Training Materials?

Here's an API service to help you get them

By STUART BOYNTON
Editorial Assistant

A CENTRAL lending library for material on training refinery personnel is one of the most successful recent innovations of the API Refining Division. Organized as part of the main library at New York headquarters, the project is expected to go a long way toward meeting the need for knowledge in the industry about the latest methods and aids being used for training personnel in refining jobs and skills.

The idea has made a big hit. Although the library has existed officially since May, 1952, it came into its own only last January, when the API circulated the first index of material accumulated since it opened. After the industry had a look at the index, the respectable trickle of requests widened into a river. Out of 59 items on the first index (with three copies of most of them) all had been borrowed by April 1, and there was a large backlog of requests for the more popular works.

The collection in the new library is composed of contributions from industry, universities and individuals. It consists of almost anything touching on refinery training that contributors want to send—company manuals, papers read at university or association symposiums, or research developed by university extension departments.

The library lends to all comers, firms or individuals, API members or not. A large part of its appeal probably stems from its policy of permitting reproduction of any of the circulating literature. This has several advantages: 1) a firm can build a permanent file of training literature for possible future use; 2) it can review and improve its established training programs by considering the methods employed by other companies; and 3) a course for training a specific skill can be set up more efficiently by utilizing the experience, as far as it fits the situation, of other firms that have built successful programs.

Trade secrets are safe because each company decides for itself what material should be contributed to the library and, therefore, might be used by others. Cost of reproduction is met by the borrower.

How does the system work? The experience of a Canadian refinery which had a difficult training problem is an illustration.

The firm's management had decided

Here's What You Can Get from the Library

BOILERMAKERS

The Texas Co.
Basic training course in boiler shop layout practices

CARPENTRY

Atlantic Refining Co.
Carpentry training program for job and zone foreman instructors

The Texas Co.
Basic training courses in:
Bill of material interpreation and blueprint reading
Construction materials and their properties
Hand and power tools and their uses
Mechanics of the steel square

CRAFTSMEN, GENERAL

The Texas Co.
Blueprint reading and interpretation

ELECTRICIANS

Sinclair Refining Co.
Electrical trainees' on the job manual
Training course for electricians and linemen

MACHINISTS

McKee, Arthur G. & Co.
Technical training program—centrifugal pumps, by Frank Drahos, Byron Jackson Co.

The Texas Co.
Basic training courses in:
Bearings—designs and uses for machinists
Blueprint reading and interpretation
Centrifugal pumps
Care and operation of compressors
Machine shop layout
Materials—standards, properties and uses
Mechanical seals for centrifugal pumps
Power units (steam turbines)
Reciprocating pumps
Rotary pumps

MANAGEMENT

Cities Service Refining Corp.
Basic management training program, 1952
Management development program leaders program, 1950
Esso Standard Oil Co.
Conference leadership. A text and reference to assist in the development of conference leaders for training programs, 1952
Humble Oil & Refining Co.
Foundations in Management, 1947, 1948 and 1950. A series of lectures delivered before management groups
McKee, Arthur G. and Co.
Orientation and indoctrination series, 1953
Shell Oil Co.
Conference chairman and instructors manual, by G. P. Koch, 1949
Conference leader's background information on day to day written communications, 1950
Conference leader's guide for 1952, Shell's 40th year
Conference outlines. What makes people tick:
The behavior pattern, 1949
The grouch, the daydreamer, the know-it-all, 1949
The troublemaker, the timid soul, the worrier, 1949
Program for security, 1953
Socony-Vacuum Oil Co.
Tips on talking
Standard Oil Co. of California
The management guide—an organization and administrative aid in the California Standard Co., 1948
Management teamwork—pamphlet outlining the objectives of management teamwork of California Standard, 1949

REFINERY PRACTICES AND PROCESSES

Chu, Ju Chin
How to train refinery engineers in distillation
McKee, Arthur G. & Co.

to set up a petrochemical branch in Alberta and was going to have to hire operating personnel with little experience of refining. The company hoped to be able to set up an intensive program for training the new men during their first few months of employment.

Training aids were needed covering both general refining practices and the operation of specific pieces of equipment—centrifugal and reciprocating pumps, compressors, fractionation columns, heat exchangers, etc.

The company's training supervisor could find only a small part of the needed texts in the firm's own files. He sent a letter stating the problem to the API library. The inquiry was answered promptly with a list of works on these topics in the library—this was before the recent index was published.

From this list the training supervisor chose and requested a number of items. After examining them he decided to reproduce the contents of several of the most useful. As will usually be the case, the texts had to be modified in some respects so as to fit the plans and organization of the company. Also, the supervisor was not able to find material on every job for which training was necessary. Nevertheless, using the library's resources offset a substantial part of the time and cost involved in organizing such a program, and it's likely that the final plan was better for having been developed out of the experience of many firms.

The library can be useful in many other ways. For instance there was the professor at a well-known college of engineering who had to organize and give a course on the internal combustion engine. He requested and was sent material on the functions of these engines in the refinery and their construction, fuels and lubricants.

Another man, an official of a small, independent refinery, evaluated the service as an aid to the new firm which is dealing with operating and training problems for the first time or with problems that are peculiar to the area. Management at this company hopes to utilize some of the techniques other refineries may have worked out while operating under similar conditions.

Consideration of the project began as early as 1951, when the committee on training of the API' Refining Division decided that a system should be set up to inform the industry about the training aids in use. A subcommittee on training literature was established. It came up with the recommendation for a source library of these materials. The final decision was for a central collection in New York at the API headquarters.

How to Use the API Training Library

Contributions to the API Library of Training Materials must meet only one requirement; they must be of a size to fit on a standard library shelf (12 x 18 in.). In addition, it is requested that three copies of each item be furnished, if possible.

Both contributions and requests for material to be borrowed should be addressed to the Librarian of the American Petroleum Institute, 50 West 50th St., New York 20, N. Y.

Revised codes and code interpretations for unfired pressure vessels and pressure piping, by Frank G. Williams, Taylor Forge and Pipe Works

Magnolia Petroleum Co.
Fundamentals of refining, 1953

Pan American Refining Corp.
Basic training manual—operating departments
Training activities 1951-52

Standard Oil Co. (Ohio)
Refinery crude unit operating manual, 1952

Texas A. & M. College

Vocational training, fundamentals of general refining practices

1 An over-all picture of a refinery and the processes involved
2 Crude oil—the primary charge stock to the refinery
3 Distillation
4 Processing and disposition of light hydrocarbons
5 Polymerization
6 Cracking, thermal and catalytic
7 Treatment of petroleum stocks lighter than lube oils
8 Lubricating oil evaluation and non-solvent treating
9 Dewaxing and solvent treating processes
10 Petrochemical and other processes
11 Heavier products, fuels and certain by-products
12 Refrigeration in the refinery
13 Metallurgy and corrosion in the refinery
14 Personnel and auxiliaries required to operated a refinery

MISCELLANEOUS

Correspondence

Standard Oil Co. of California
Correspondence handbook—basic principles of good letter writing and their application to company requirements, 1949

Corrosion

Bridgeport Brass Co.
Technical handbook, revised 1952
Condenser and heat exchange tube handbook, 1953

Driving

Esso Standard Oil Co.
Driver testing and training, 1951
Manual for safety training of lift truck operators

Films and Audio-Visual Aids

Socony-Vacuum Oil Co.
Audio-visual aids Buere's guide
Film catalog
Practical use of audio-visual aids in industrial training, 1949
The what and why of audio-visual aids

Personnel Relations

Standard Oil Co. of California
Company's personnel relations program—a summary of talks, 1949
Here's your opinion—results of 1951 employee opinion poll

Piping and Tubing

Babcock & Wilcox
Properties and methods of working seamless and welded tubes and pipes of the B&W stainless Croloys
Methods of working seamless tubes and pipes of the intermediate B&W Croloys
Properties and methods of working seamless tubes and pipes of the B&W Nicloys
Properties of carbon and alloy seamless steel tubing for high-temperature and high-pressure service

Supervisors

Esso Standard Oil Co.
Basics of supervision
Supervisor training, 1949

Humble Oil & Refining Co.
Fundamentals of supervision, Vols. 1 and 2

The Texas Co.
Procedure manual, supervisory program

Safety

McKee, Arthur G. & Co.
(See under Refinery Practices and Processes)

Technical

Esso Standard Oil Co.
Technical training program, Baltimore refinery

Welding

Socony-Vacuum Co.
Trainers guide for electric arc-welding programs, 1950

Work Sheets

Socony-Vacuum Oil Co.
Job methods work sheet

API Catalyzes Refining Progress

By JOHN W. NEWTON
Vice President for Refining
American Petroleum Institute

LIKE the catalysts the oil companies use in processing, the American Petroleum Institute Refining Division functions to enlarge and speed up the flow of essential technical information and data to the petroleum refiners. This swift dissemination of fact and opinion has put the refining industry in the forefront of the quick adaptation of better equipment and improved techniques.

The Producing and Marketing Divisions of the API operate along the same lines as Refining. The constant assembling of fundamental knowledge in all branches of the petroleum industry under the sponsorship of the API in effect spreads the work of solving common technical problems. This achievement has made the API unique among industry associations in the country.

It is not the Refining Division's purpose nor practice to discuss competitive problems or information; rather, the work of the Division offers every refiner solid facts from which he individually can find ways to improve his products' quality, increase his operating efficiency, better his public relations and accomplish many other objectives.

The current and recently completed work of the Division will receive continued interest as additions are made to this existing reservoir of technological fact. A review of these projects will show some of the directions in which they are most likely to benefit refiners and, through them, the U.S. public.

Automotive Fuels: For many years, in cooperation with the auto makers, the Division has sponsored research projects dealing with equipment, lubricants, and fuels. These have resulted in direct gains for the motoring public through advanced engine design and more effective petroleum fuels. They have permitted refiners to plan production of higher quality fuels and carry these production changes out efficiently and economically. In addition to the civilian effort, a large segment of this research has been devoted to defense activities, which even more vitally affect the essential public interest.

The Division, working through the Southwest Research Institute in San Antonio, Texas, has investigated some 190 individual cars covering 19 makes and yearly models ranging from 1946 to 1952. Eight oil companies furnished fuels with widely varying characteristics.

Vapor Lock and Cold Starting: Of basic importance have been the recent investigations into vapor lock and cold-starting characteristics of military vehicles. In the summer of 1951 and winter of 1951-52, exhaustive tests were made on 12 different types of military vehicles. Using a great many commercial petroleum fuels, the tests gave direct results in the form of improvements in the fuel injection systems and in a description of the gasoline properties that would give best performance. These were carried on under various conditions.

Diesel Fuels and Lubes: Research activities on diesel problems have extended to military aircraft engine design, fuels and lubrication. Combat vehicles of all types have been placed under various studies as the Division of Refining has extended its cooperative efforts with various segments of the Armed Forces.

An example of this continuing program is the current work of establishing, with U.S. Army Ordnance, the proper engine-lubricating oil relationship in air-cooled tank engines.

Other projects have looked into the storage stability of diesel fuels, gasolines and jet fuels—work which has resulted in vast savings of product and energy.

Public Relations: The API's Oil Industry Information Committee, itself not a part of the Division of Refining, has done some notable work in educating both the public and the oil industry.

This educational program has already had some distinct benefits in improving the industry's relations with the public. It is not, however, the only way in which the API has had influence in gaining public confidence and appreciation for the refiner. Many segments of the various research programs have dealt with problems of direct concern with these relations.

Refinery Waste Disposal: One of the most important of these has been the continuing program of investigation into the technical problems of refinery waste disposal.

While the major portion of the nation's refining capacity is concentrated in relatively few areas, the nation as a whole is becoming increasingly conscious of the over-all task of maintaining cleanliness of streams and air at high levels of purity. The oil industry shares with all others this responsibility. Anyone familiar at all with the steps taken in recent years can attest to the sincerity and aggressiveness with which the oil companies, individually and jointly, have accepted their portion of the task.

The development of technical information dealing with the treatment of refinery waste products has been one of the longest established goals of the Division of Refining.

The Committee on Disposal of Refinery Wastes, through its support of research projects in leading research institutions and by free exchange of industry "know-how," has helped keep the refining branch abreast of modern technology in both water and air pollution abatement.

Product Testing: Almost at the opposite extreme, in so far as public attention is concerned, is the Division of Refining's work in the measurement, sampling and testing of petroleum and its products.

Of particular importance, as an example, is the work done on pressure-temperature relations of petroleum mixtures, a project undertaken in 1949 at Northwestern University. When completed — perhaps in 1954 — this study will undoubtedly have yielded information of extreme value to design engineers in many industries.

Central Abstracting: Another endeavor initiated by the Division is the Central Abstracting Service. Culminating a cooperative study by oil technologists, the API has started a service aimed at furnishing weekly abstracts of 100 leading U.S. and foreign technical publications to subscribers.

Employee Training: In employee training, the Division of Refining has accumulated training literature and counseled with the pump manufacturers and other suppliers on making their training literature more effective.

The list of such contributions can also include providing the industry with viscosity sampling materials, and with engineering techniques for greater safety.

The fundamental knowledge constantly being assembled under API sponsorship has immediate and direct meaning in the refiner's search for technological improvement. Its importance can be recognized only by its use and by furtherance of its continued gathering through wholehearted support of the API program.

API Committee Activities—1953

Annual progress reports on programs under way by Refining Division technical committees

One of the most important activities of the American Petroleum Institute Division of Refining is to organize and coordinate various technical committees, which carry out studies and projects of mutual interest to the petroleum processing industries. To acquaint the industry more fully with the work of these committees, these progress reports have been prepared for us by the chairmen, with the cooperation of W. T. Gunn, director of the Division.

ELLIOTT B. McCONNELL

Chairman, Advisory Committee

Mr. McConnell, Standard Oil Co. (Ohio), graduated from Cornell University chemical engineering school in 1923 and was employed by Standard Oil Co. (N. J.). In 1928 he joined Standard of Ohio as assistant to the vice president in charge of manufacturing, was made general manager of the manufacturing department in 1945, and in 1946 was appointed vice president and elected a director.

JOHN W. NEWTON

Chairman, General Committee

Mr. Newton, Mongolia Petroleum Co., Beaumont, received a degree in chemical engineering from Texas A&M. He taught chemistry there for 2 years, and then joined Magnolia as a chemist in 1914. After successive promotions, he became a director and vice president of the company in 1938, and is now vice president and manager of refining.

CHARLES M. RIDGEWAY

Chairman, Program Committee

Mr. Ridgeway, Pure Oil Co., Crystal Lake, Ill., received a B.S. in chemical engineering from the University of Michigan. He has been with Pure since 1932, in various capacities at the company's refineries and in the Chicago office. From 1942-43 he served with PAW, returning to Pure as technical assistant for the refining department. Since 1949 he has been manager of the research and development laboratories.

Automotive Research Committee

C. E. DAVIS, *Chairman*

Mr. Davis has been with Shell Oil Co. since 1917, starting as a clerk in the Cushing, Okla., refinery. He moved to Wood River, to Houston, to St. Louis, and in 1943 was made general manager of the manufacturing department in New York. He became assistant to the vice president in charge of manufacturing in 1949.

R. C. ALDEN

Chairman, Subcommittee on Fuel Surveys

(see photo, Committee on Petroleum Products)

THE Automotive Research Committee continued to sponsor studies and investigations to promote improvements in fuels and lubricants and their more efficient utilization. Many of the research projects were carried out by the Coordinating Research Council under the joint sponsorship of the American Petroleum Institute and the Society of Automotive Engineers and are of considerable benefit both to the petroleum and automotive industries.

Surveys of commercial motor and aviation gasoline properties, diesel fuels and turbine fuels are made annually by the U. S. Bureau of Mines with the cooperation of the Automotive Research Committee and distributed to the automotive and petroleum industries. The desirability of including residual fuels in future surveys is being considered.

Vapor lock studies conducted by the Southwestern Research Institute were concluded during the year and a final report is in preparation. A new volatility project which will include studies on vapor lock, stalling and hot starting has been inaugurated by CRC.

Among the more important CRC projects is a study of the storage stability of motor gasolines, turbine fuels, and diesel fuels. This study was initiated primarily at the request of the military services, but is yielding information of considerable interest commercially. Other fundamental fuel studies include projects at the Massachusetts Institute of Technology and the University of Wisconsin for developing techniques and apparatus for the instantaneous measurement of gas temperatures inside the combustion chambers of internal combustion engines. In cooperation with the U. S. Bureau of Mines, fundamental investigation of ignition quality of diesel fuels is being continued using a constant volume bomb procedure.

In motor gasolines major emphasis has been placed on the phenomenon of preignition and its relation to octane requirement. Investigation of turbine fuels covers high temperature volatility characteristics and the relationship between combustion characteristics and turbine efficiency, including depositing tendency. In the Diesel fuel field the full scale tests on railroad Diesel engines has entered the final phase and a progress report on the first phase has been issued to the participants.

Lubrication projects currently in progress include a study of engine lubricant relationships and a new project on gear lubricants. A design for a new test engine for evaluating the performance of engine lubricants has been finalized and a supplier has been selected on the basis of price and ability to conform with the committees' requirements.

Smoke and Fumes Committee

W. L. STEWART, Jr., *Chairman*
Mr. Stewart, Union Oil Co. of California, Los Angeles, attended Stanford University and was graduated by M.I.T. in 1923. He began with Union Oil the same year and worked as a research assistant until 1925, when he became secretary of the manufacturing committee. In 1927 he was promoted to executive assistant and elected a director. He became a director of manufacturing a year later, a vice-president in 1930 and, in 1942, the company's executive vice-president.

THE Smoke and Fumes Committee was formed in 1952 for the purpose of sponsoring research on the growing problem of air pollution. The research program adopted by the committee was designed to develop basic information on the causes of air pollution in urban areas and to obtain reliable data concerning the contributions to the problem of both the petroleum industry and its customers.

The funds for use in financing the Committee's program were made available on January 1, 1953. Some three weeks later, the Executive Committee met with the Director, Division of Refining, and the Executive Secretary and appointed an *ad hoc* five-man Technical Advisory Committee to assist the Executive Secretary in selecting the research institutions best qualified to conduct research on the projects it was proposed to establish. The Technical Advisory Committee held its first meeting in February, with the Director, Division of Refining, and the Executive Secretary in attendance. It was recommended that several additional institutions be contacted in regard to certain projects before final decisions regarding their placement were made.

These recommendations were followed and, at the second meeting of the Executive Committee in April, final recommendations were made concerning the location and proposed cost of 11 research projects.

The recommendations presented to the Executive Committee were accepted by it, and the task of negotiating contracts covering the projects was begun with the institutions selected. Research work under the first contract signed began on May 1, 1953.

Research projects were placed at seven institutions.

1—The Industrial Hygiene Foundation of America, Inc. was chosen as the site of a project for the selection and demonstration of the method most suitable to the determination of the path of gases after emission from a given source.

In setting up this project, it was soon discovered that no suitable method of tracing emissions was available and research would have to be carried out to develop a suitable method. At present two lines of attack are being followed. One of these involves the dispersal of mercury vapor from a given source and the development of sensitive methods for the detection of the vapor after subsequent dilution by diffusion and convection. The other possible and promising method of tracing emissions being studied involves introducing a finely-divided metallic compound into the given source. Minute amounts of the compound carried to distinct locations are then recovered by drawing measured quantities of the contaminated air through filter paper. The metal in the samples is then made radioactive by exposure to neutrons in the Oak Ridge pile. By allowing appropriate time to elapse between activation and counting, the radioactivity of interfering elements will have disappeared by normal decay. Hence, the amount of the tracer metal, and its concentration in the air volume sampled, may be determined by a count of its remaining radioactivity.

2—The Armour Research Foundation was selected for two projects.

One of these projects has for its objective the development of an analytical method for the determination of small amounts of ozone in polluted industrial atmospheres. The stipulation was made that the method developed should depend, if possible, upon physical rather than chemical properties of ozone and thus be specific for ozone.

The other project has for its objective the determination of the quantity and types of partially oxidized, thermally cracked and unchanged hydrocarbons present in the effluent gases from various types of domestic and industrial devices burning petroleum products. It appears that research on this project will be completed at the end of one year's time. The results of the study indicate that air pollution resulting from unburned hydrocarbons, cracked hydrocarbons and partially oxidized hydrocarbons from the burning of petroleum fuel is insignificant in cities of more than one million population which use petroleum products exclusively as domestic and industrial fuel.

3—The Kettering Laboratory of the University of Cincinnati was selected as the site of a project involving a survey of the ozone content and ozone forming capacities of the atmospheres of selected industrial cities.

Ten cities were selected for survey and the work in five of these cities has been completed. The preliminary results indicate that, contrary to what has been believed in the past, Los Angeles may not be unique in respect to the high ozone content of its atmosphere.

4—The Engineering Experiment Station of the University of Illinois was chosen as the location of a project for a study of the effect of nitrogen oxides, nitric acid and various particulate matter upon the sulfur dioxide-sulfur trioxide equilibrium in an atmosphere irradiated by sunlight.

Exceptionally good progress has been made on this project, the first portion of the study already having been completed. The preliminary results indicate that in sunlight, in the presence of water vapor and nitrogen oxides in concentrations which may exist in polluted atmospheres, the oxidation of sulfur dioxide to sulfur trioxide is a very slow reaction, only about 0.1% of the amount of sulfur dioxide present being oxidized to sulfur trioxide during each hour of reaction time.

5—The Franklin Institute was chosen to study the reactions occurring in sunlight between nitrogen dioxide and hydrocarbons of the various types present in gasoline, as well as the reactions occurring between ozone and hydrocarbons of the same type.

These studies are being carried out by the aid of infrared spectroscopy. Preliminary results indicate that the reaction products of the nitrogen dioxide hydrocarbon systems are quite easily identifiable. However, at the present time some uncertainty remains concerning the identity of some of the products formed in the reaction between ozone and certain types of hydrocarbons.

6—The University of Wisconsin also was selected as an additional site for the study of the reactions occurring between nitrogen dioxide and hydrocarbons.

WILLIAM NADEN, *Vice Chairman*
Mr. Naden, Esso Standard Oil Co., New York, joined the company over 20 years ago. His first post with Esso was as a chemist in the Everett, Mass., refinery. Between 1934 and 1944 he was general superintendent of the Everett and Baltimore refineries, and in 1944 was made manager of employee relations. Two years later he became a director, and in 1949 was named a vice-president in the manufacturing department. He was appointed general manager of the department in 1950.

VANCE N. JENKINS, *Executive Secretary*
Mr. Jenkins, Union Oil Co., of California, Brea, Calif., was graduated in 1918 from Southwestern University, Georgetown, Texas, with a B.A. in chemistry. After brief periods with The Texas Co. he left to teach and study at Emory University during 1920-21, and to attend the graduate school of chemistry at the University of California during 1921-22. From 1922 to 1930 he was again employed by The Texas Co. He began to work for Union Oil in 1932, and is now supervisor of the research division.

H. G. VESPER
Chairman, Technical Advisory Committee
Mr. Vesper, California Research Corp., San Francisco, was graduated by California Institute of Technology in 1922 and has been with Standard Oil Co. of California since. In 1931 he was transferred from manager of the El Segundo branch of Standard's research and development department to San Francisco, as assistant to the general manager of the department. He was elected president of California Research Corp., Standard's research affiliate, in 1945.

R. M. SHEPARDSON
Chairman, Project Advisory Committee No. I
Mr. Shepardson, Esso Laboratories, received a C.E. degree from Rensselaer Polytechnic Institute in 1930, and immediately thereafter joined Esso Standard Oil Co. at the Bayway, N.J. refinery. In 1935 he was transferred to the Esso Laboratories (process division), and in 1947 was appointed director of these laboratories.

B. A. FRIES
Chairman, Project Advisory Committee No. II
Mr. Fries, California Research Corp., Richmond, Calif., received a B.S. and Ph.D. from the University of California, Berkeley. In 1943 he was employed by the Manhattan Project, for which he conducted research in plutonium separation processes at the University of Chicago, Oak Ridge and Hanford. In 1945 he joined California Research Corp. as a research chemist.

W. J. COPPOC
Chairman, Project Advisory Committee No. VI
Mr. Coppoc, The Texas Co., New York, received a B.S. from Ottawa University, Ottawa, Kans. in 1935 and his M.A. and Ph.D. degrees from Rice Institute in 1937 and 1939. He began work with The Texas Co. in 1938 while attending college. In 1944 he was appointed assistant to the assistant chief chemist at Port Arthur, was transferred in 1949 to the Beacon, N. J., laboratories as assistant research director, became associate director in 1951, director in 1953.

R. N. GILES
Chairman, Project Advisory Committee No. VIII
Mr. Giles, Standard Oil Co. (Ind.), Chicago, received his B.S. from the South Dakota School of Mines, and his Ph.D. from Ohio State University in 1930. He then joined Standard of Indiana as a chemist at Casper, Wyo. He was transferred in 1934 to the Whiting laboratory, and in 1945 was placed in charge of all technical service activities at the Whiting refinery. In 1947 he became director of technical service for all of Indiana Standard's refineries.

HARRY LEVIN
Chairman, Project Advisory Committees Nos. IV and V
(see photo, Analytical Research Committee)

K. M. WATSON
Chairman, Project Advisory Committee No. VII
(see photo, Petroleum Products Committee)

Because of the fact that nitric acid is a more probable constituent of the amosphere than nitrogen dioxide when ozone is present, the work at the University of Wisconsin will be concerned chiefly with nitric acid reactions. This project was the last one to be activated and, hence, no preliminary results of great importance are yet available.

7—Stanford Research Institute was selected as the site of two projects.

Because this institution already had laboratory facilities in the Los Angeles area, it was given the problem of determining the mechanism of the formation of ozone in polluted industrial atmospheres. Its second assignment was the development of a method for the determination of the amount of total organic substances in polluted industrial atmospheres.

Considerable progress has been made on both phases of this project. Preliminary data indicate that contrary to published statements and popular belief, nitrogen dioxide and saturated branched chain hydrocarbons play no part in the formation of ozone. A method of isolating the substance or substances which form ozone on irradiation by sunlight has been developed, and it is believed there is a distinct possibility of the substance or substances responsible being identified within the near future.

It was found possible to modify an infrared analyzer for use in the determination of total organic substances in the atmosphere. The construction of an instrument embodying the necessary modifications will be begun within a short time.

Ever since the original postulation of the theory that smog is caused by reactions in the atmosphere between oxidizing substances and hydrocarbons derived from petroleum, there has been sharp disagreement concerning the degree to which this theory represents fact. In particular, there has been much argument concerning the relative amounts of hydrocarbons derived from petroleum and from other sources, such as rubbish burning, in the atmospheres over our cities. This point can be settled by a determination of the amount of radioactive carbon contained in the organic material in a given atmosphere. It is proposed to initiate a project of this kind within the near future.

There also has been a large amount of contradictory data presented on the subject of visibility reduction caused by aerosols resulting from the reaction of unsaturated hydrocarbons with ozone. Some authorities claim such reactions in the atmosphere are the cause of most of the reduced visibility over cities using petroleum products as the chief fuel. It is proposed to establish a project to study the conditions under which aerosols are formed by reaction of unsaturated hydrocarbons and ozone, as well as the rate of visibility reduction if such aerosols are found to form.

Committee on Refinery Equipment

R. H. VENN, *Chairman*

Mr. Venn, Humble Oil and Refining Co., Houston, received a B.S. from Wayne University and an M.S. from M.I.T., the latter in 1934, and started with Humble Oil as a junior chemical engineer at the Baytown refinery. In 1938 he became section head of the technical service division, was promoted to senior project engineer in 1942, and in 1945 was named technical assistant to the director in charge of refining. In 1950 he was named manager of refining operations.

THE Committee on Refinery Equipment is concerned with matters pertaining to the design, construction, inspection and repair of refinery equipment. It fosters the API program of standardization in these fields where standards do not exist, or where the standards developed by other bodies do not meet adequately the needs of the refining industry. It formulates recommended practices for industry-wide use in the promotion of efficiency and safety in refining operations. Through its representatives in other organizations, it attempts to insure that standards developed by those organizations are acceptable to the petroleum refiner.

The Subcommittee on Electrical Equipment, under the chairmanship of L. M. Goldsmith, continued its study of the design of refinery electrical installations. Its purpose is the development of recommendations which can be accepted by the petroleum industry as well as the manufacturers of equipment and the process plant contractors. It is expected that this work will culminate in a manual of recommended practices for electrical installations in refineries.

The Subcommittee on Mechanical Equipment, E. F. Voss, chairman, worked in cooperation with the Manufacturers Subcommittee on Centrifugal Pumps, Lynn Sawyer, chairman, on Specifications for Centrifugal Pumps for General Refinery Service. The specification is complete and is now in the process of being printed.

The Subcommittee on Pressure-Relieving Systems, under the chairmanship of J. C. Souder, continued in its effort to formulate a workable recommended practice for the design and construction of refinery pressure-relieving systems. At present, the greatest effort is being expended toward obtaining agreement on certain controversial design data relative to heat input to vessels involved in fires.

The Subcommittee on Unfired Pressure Vessels, N. J. Rees, chairman, has been considering certain proposed supplements to the API-ASME Code for Unfired Pressure Vessels having to do with materials, nozzle reinforcement, and inspection rule changes. Study groups are considering the general subject of welding quality, the design of alloy-clad vessels, and the fabrication of low chrome-moly vessels. The subcommittee also is working toward the development of a specification for graphitization-resistant steel.

The Subcommittee on Low-Pressure Storage Tanks, under the chairmanship of W. L. Bowler, in cooperation with a Manufacturer's Subcommittee, H. C. Boardman, chairman, is reviewing a final draft of recommended rules for the design, construction, and inspection of large, low-pressure welded storage vessels for service at pressures above the limitation of API Standard 12C, but below the range of the API-ASME Code

C. C. TATE, *Sponsor*

Mr. Tate, Phillips Petroleum Co., Bartlesville, received a B.S. in electrical and mechanical engineering from Kansas State College, and in 1932 joined Phillips as an engineer. His experience in refining operations includes 12 years in Borger, Texas, and Okmulgee, Okla., refineries. From 1945-48 he was Phillips' special representative in Mexico. He returned to Bartlesville in 1949 to take his present position as manager of the refining department.

H. G. MANGELSDORF

Chairman, Subcommittee on Corrosion

Mr. Mangelsdorf, Esso Standard Oil Co., New York, a graduate of Kansas State College, has an M.S. in fuel and gas engineering from M.I.T. He joined Esso in 1934 at Baton Rouge, where he subsequently became manager of the chemical products division and later general superintendent of the petroleum products division. In 1950 he was appointed general superintendent of the Bayway refinery. He was named manager of east coast manufacturing in 1952.

L. M. GOLDSMITH

Chairman, Subcommittee on Electrical Equipment

Mr. Goldsmith, Atlantic Refining Co., Philadelphia, was graduated from Drexel Institute of Technology, which later bestowed on him the honorary degree of doctor of science. He pioneered the adaptation of the diesel-electric drive to tow-boats and medium-size ocean-going vessels in 1923 and was an early advocate of electric welding for pipe lines. He is Atlantic's chief engineer and vice president of manufacturing.

G. N. EHLY

Chairman, Subcommittee on Instruments

Mr. Ehly, Atlantic Refining Co., Philadelphia, received a diploma in mechanical engineering from Drexel Institute of Technology in 1933 and completed a 3 yr. course in petroleum refining at Pennsylvania State College in 1943. He was employed by Atlantic in 1933 at the Philadelphia refinery, and in 1939 became senior test engineer of the mechanical laboratory section, mechanical department. In 1946 he was made the department's instrument section supervisor.

E. F. VOSS

Chairman, Subcommittee on Mechanical Equipment

Mr. Voss, Humble Oil and Refining Co., Houston, attended Technical University of Aachen, Germany, in 1913-14, before coming to the U.S. in 1916. He was graduated from M.I.T. with a B.S. in 1918, and the University of Paris awarded him a doctorate in physical chemistry in 1923. He returned to the U.S. as an instructor at M.I.T. during 1923-24, then joined Humble. In 1927 he became chief refinery engineer.

LYNN SAWYER

Chairman, Manufacturers' Subcommittee Centrifugal Pumps

Mr. Sawyer, Byron Jackson Co., Los Angeles, secured his electrical and mechanical engineering education via extension courses. In 1929 he was employed by Byron Jackson as sales engineer. He was promoted to branch manager in 1933, and in 1938 was transferred in this capacity to New York. He became general manager of the pump division in 1943, a vice president in 1945, and board member in 1952.

J. C. SOUDER
Chairman, Subcommittee on Pressure-Relieving Systems

Mr. Souder, Standard Oil Development Co., Linden, N.J., was graduated by Virginia Polytechnic Institute with an M.E. in 1929. He joined Standard Oil Co. (N.J.), and was assigned to the development company. After three years as an inspector with the refinery equipment group he transferred to the Aruba, N.W.I., refinery. Since 1946 he has been with SOD as an engineering consultant.

W. L. BOWLER
Chairman, Subcommittee on Low-Pressure Storage Tanks

Mr. Bowler, Pure Oil Co., Chicago, was graduated from Lehigh University in 1922. For two years he was with the Chile Exploration Co., and from 1926 to 1930 in the inspection department of Jersey Standard. After three years with the Taylor Forge and Pipe Works he joined Pure, and since then has been concerned with general refinery problems and plant maintenance.

L. P. STILLMAN
Chairman, Manufacturers' Subcommittee on Safety and Relief Valves

Mr. Stillman, Manning, Maxwell and Moore, Tulsa, holds a B.S. from Iowa State College. He spent five years as an operator of pressure stills for the Cities Service refinery in East Chicago, Ind., and two more years in the company's Tulsa office. After two years with an engineering firm, he joined Manning, Maxwell and Moore as a sales engineer and became manager of the products division.

H. C. BOARDMAN
Chairman, Manufacturers' Subcommittee on Low-Pressure Storage Tanks

Mr. Boardman, Chicago Bridge and Iron Co., Chicago, received a B.S. degree in civil engineering in 1910 and a C.E. degree in 1926 from the University of Illinois. He worked for Chicago Bridge and Iron from 1910 to 1916 and from 1926 until the present. During the latter period he served as research engineer and, since 1945, as the director of research.

for Unfired Pressure Vessels.

The Subcommittee on Corrosion, H. G. Mangelsdorf, chairman, fosters the study of corrosion of refinery equipment.

The Subcommittee of Refinery Inspection Supervisors, W. K. Brown, chairman, is concerned with the writing of Recommended Practices for Refinery Inspections. Parts I through V have been completed. A Designer's Subcommittee, under the chairmanship of J. H. Rickerman, is working with Mr. Brown's group.

A study group under the chairmanship of C. H. Samans is gathering information on storage tank failures by brittle fracture.

The Subcommittee on Valves, R. H. Bungay, chairman, cooperates with the Manufacturer's Subcommittee, under the chairmanship of W. P. Kliment, to perpetuate the valve standards which are considered acceptable to the petroleum industry.

The Subcommittee on Tank Accessories and Cleanouts, E. E. Kerns, chairman, has as its objective the formulation of recommendations relative to the standardization of tank appurtenances and openings. Last year, it recommended that provision be made on cone-roof tanks for attachment of cables for painters, inspectors and maintenance men's scaffolds and that the number, size and location of manholes and cleanout openings be referred to the Committee on Tank Cleaning.

The Subcommittee on Instruments has completed its work in the preparation of Part V, Instruments, of the Recommended Practices for Refinery Inspections. Copies of this Part were scheduled to be available May 1.

W. K. BROWN
Chairman, Subcommittee on Refinery Inspection Supervisors

Mr. Brown, Standard Oil Co. (Ind.), Whiting, is a graduate of the University of Texas, where he received his B.S. in 1925, and of the University of Illinois, with a M.S. in 1927. Except for two years with a firm of consulting engineers, he has been in the engineering division of Indiana Standard's Whiting refinery. He has been assistant chief engineer in charge of the plant engineering department since 1945.

E. E. KERNS
Chairman, Subcommittee on Tank Accessories and Cleanouts

Mr. Kerns, Standard Oil Co. (Ohio), Cleveland, received his M.E. degree from Carnegie Institute of Technology in 1925. In 1928 he joined the Louisiana Oil Refining Corp., eventually becoming mechanical superintendent of the Bossier City refinery. In 1934 he was employed by Standard, of Ohio. He is presently in charge of the materials and equipment section of general engineering.

R. H. BUNGAY
Chairman, Subcommittee on Valves

Mr. Bungay, Union Oil Co. of California, Los Angeles, graduated in 1930 with a B.S. from the California Institute of Technology. He was employed by Standard Oil of California from 1930-40, was with the Army from 1940-46 and joined Union Oil upon his discharge. At present he is supervisor of engineering and construction in the manufacturing department, and is in charge of design and construction of major refinery expansion programs.

J. H. RICKERMAN
Chairman, Designers' Subcommittee on Refinery Inspections

Mr. Rickerman, M. W. Kellogg Co., New York, received a B.S. in mechanical engineering from the University of Illinois and was first employed as a steam engineer for Commercial Solvents Corp. He joined M. W. Kellogg in 1936, and became its chief standards engineer in 1949. He has also been a part-time instructor of graduate courses in petroleum engineering design at Columbia and New York Universities.

N. J. REES
Chairman, Subcommittee on Unfired Pressure Vessels

Mr. Rees, Socony-Vacuum Oil Co., New York, received a B.S. in 1931 and an M.E. in 1932 from the College of the City of New York. For six years he worked with the U.S. Navy Department, then in the power industry, and for three years with the M.W. Kellogg Co. He joined Socony-Vacuum in 1944 and is now design engineer in the refinery engineering division.

W. P. KLIMENT
Chairman, Manufacturers' Subcommittee on Refinery Valves

Mr. Kliment, Crane Co., Chicago, started working for the Crane Co. in 1924, at the age of 23, and is now engineer of standards in charge of the application of codes, specifications, and correlative standardization data pertaining to the valve and fittings industry.

Committee on Training

D. S. TURNER, *Chairman*
Mr. Turner, Standard Oil Co. (Ohio), Cleveland, attended Westminster College and Youngstown College and majored in social science and metallurgy, taking his B.S. in the latter. He was employed by Carnegie Illinois Steel Corp. for 13 years, serving as assistant to the superintendent of the personnel division, and as director of training in the Youngstown district. He joined Sohio in 1946 as staff assistant in the industrial relations division of the manufacturing department training activities.

THE Committee on Training is responsible for developing and improving training methods, techniques and training aids in the refining industry. It is also interested in keeping the men responsible for refinery training informed on the latest developments, and offers assistance in organizing and promoting training. The sponsor for the Committee on Training is Mr. George V. Dunham, Vice-President of Socony-Vacuum Oil Co.

The Subcommittee on Pump Manuals has prepared specifications for training manuals. Mr. John Stadtherr and his subcommitte have worked with a subcommittee of representatives of pump manufacturers headed up by Mr. George V. Shaw. The specifications have been very well received by the pump manufacturing industry and the Hydraulic Institute. These Subcommittees are now preparing general training manuals on:

1—Centrifugal Pumps
2—Rotary Pumps
3—Reciprocating Pumps

Mr. Ray Faller and his Subcommittee on Training Literature have announced to all members of the Refining Division, the start of the Training Library as a part of the regular library of the API. The training material currently housed in the Training Library is available to anyone in the Refining Industry who is interested in training. (A detailed story on this material appears in this issue, pg. 712.)

Mr. W. W. McMullen, Jr., is chairman of a Subcommittee on Economics, which is making a study of what training has been done in the refining industry in the field of economics.

The Subcommittee on Committee Work, headed up by Mr. Taylor Rushing, submitted the final draft of a booklet entitled, "The Three R's for Committeemen." The Refining Division felt its members needed a clear picture of their responsibilities. This booklet was prepared to meet this need. The three R's referred to in the title of the booklet are Responsibilities, Relationships, Rewards. Copies of the booklet have been sent to all members of the API.

A major project undertaken by the Committee on Training in Refining is the formation of area subcommittees. The Committee feels that such subcommittees can do a lot to advance refinery training throughout the United States. The membership of these subcommittees would be composed largely of the men who are organizing, coordinating, and conducting training programs at the refinery levels. These subcommittees will be patterned after the Gulf Coast Subcommittee, which has been operating for a number of years. The service they have performed in their area has proved the value of area subcommittees. The chairmen in charge of organizing these area Subcommittees are:

Mr. W. O. Barnes—San Francisco and Los Angeles areas.

Mr. E. R. Laminack—New York-Philadelphia area.

Mr. M. L. Mullins—Great Lakes area.

Mr. R. H. Gould—Mid-Continent area.

The Committee on Training felt there was a definite void of "Case Studies" for use in supervisory training. The committee agreed to make a compilation of problems that have occurred in the field of human relations in the refining industry. Mr. Stadtherr is in charge of collecting these cases.

Committee on Analytical Research

C. E. HEADINGTON, Chairman
Mr. Headington has been with Atlantic Refining Co. in Philadelphia since 1929—in the research and development department—and was made division research director in 1944. He received his B.A. from Upper Iowa University in 1927, and his M.S. in chemistry from Iowa State College in 1929, studying during 1927-28 as an industrial research fellow.

THE Committee on Analytical Research is a relatively young activity in the API being an outgrowth of the cooperative program between the government and the petroleum industry during World War II. Its function is to promote analytical research in the petroleum industry and to develop new analytical techniques which will aid petroleum refining operations.

The results of its analytical research programs are made available to the industry through group sessions on this subject, which are held annually at the API midyear meetings; and through *Analytical Chemistry*, where the papers presented at the group sessions are ultimately published.

Most of the research programs of the committee are carried out by means of discussion and cooperative work in nine subcommittees, which are currently engaged in the following programs:

1—The Subcommittee on Trace Elements in Crude Oils and Catalytic Charge Stocks, headed by Harry Levin of The Texas Co., is developing quick and reliable methods for determining minute amounts of metals such as vanadium, nickel, iron and sodium and others in oil fractions that are charged to units employing catalytic processes.

2—The Subcommittee on Analysis of Cracking Catalysts, headed by R. O. Clark of Gulf Research, is developing methods for determining

G. S. DUNHAM, *Sponsor*

Mr. Dunham, Socony-Vacuum Oil Co., New York, is a Cornell University graduate of 1922. He was employed by the White Eagle Oil Corp. (now part of Socony-Vacuum) at its Augusta, Kans., refinery in 1925, later becoming superintendent of the firm's Ft. Worth, Texas, plant. In 1936 he became manager of Socony-Vacuum's refinery engineering division and later vice chairman of the manufacturing committee in charge of refineries in the eastern and central states.

TAYLOR M. RUSHING

Chairman, Subcommittee on Committee Work

Mr. Rushing, The Texas Co., New York, was graduated from Southwestern University in 1925. He took his graduate work at the University of Texas and the University of Southern California, and was a public school principal for 17 years. In 1943 he became associated with Lamar College, Beaumont, Texas, remaining there until 1945, when he accepted the job of supervisor of training for The Texas Co. refining department.

W. W. McMULLEN

Chairman, Subcommittee on Economics Training

Mr. McMullen, Magnolia Petroleum Co,. Beaumont, Texas, was graduated with a B.S. in mechanical engineering from Texas A. & M. College. He has been with Magnolia at the Beaumont refinery since 1947 and was in the engineering department until 1952, at which time he was promoted to training director. With the engineering department he performed maintenance and design engineering and field inspection work.

W. E. BENNETT

Chairman, Gulf Coast Subcommittee

Mr. Bennett is supervisor of personnel training, Cities Service Refining Corp., Lake Charles, La. Prior to joining Cities Service in 1944, he attended Louisiana State University, served in the merchant marine, and worked in the construction field. After moving through several mechanical department posts at Lake Charles, he took on his current responsibilities. He has also served in union contract negotiations for the firm.

R. R. FALLER

Chairman, Subcommittee on Training Literature

Mr. Faller, Ethyl Corp., New York, received his B.S. from New York University and his M.S. from Yale. Ethyl employed him in 1931 as an automotive engineer in the Dayton, Ohio, office. Five years later he became assistant division manager at Dayton, and in 1939 was assigned to the Detroit laboratories as director of training. In 1945 he became manager of personnel and employee relations at the laboratories, and was made director of training in 1948.

J. J. STADTHERR

Chairman, Subcommittee on Pump Manuals

Mr. Stadtherr, Pure Oil Co., Chicago, was graduated from the University of Missouri with a B.S. and took post-graduate work in chemical engineering at Ohio State University. From 1927-37 he was a chemist for Sinclair Refining Co. He then joined Pure as a resident chemist for the Heath, Ohio, refinery, and was subsequently assistant general operating foreman, and training supervisor. Since 1949 he has been training director for the refining division.

W. W. HITCHCOCK

Chairman, Subcommittee on Case Studies

Mr. Hitchcock, Sinclair Refining Co., Houston, entered the oil industry in 1920 as a "roughneck" in oil field production. In 1921, Sinclair employed him as a stillman in its lube oil operations, transferring him in 1924 to light oil operations. He was made a foreman of various refinery operating divisions in 1929 and promoted to industrial engineer in 1948. In 1950 he was appointed manager of refinery training and safety for the company.

GEORGE V. SHAW

Chairman, Manufacturers' Subcommittee on Pump Manuals

Mr. Shaw, Ingersoll-Rand Co., New York, received his technical education at the Polytechnic Institute of Brooklyn. He worked up through the ranks in engineering with the Newburgh Ice Machine and Engine Co. and the Alberger Pump and Condenser Co. He has been with Ingersoll-Rand for 35 years and chief engineer of its pump sales division since 1938.

H. Y. HYDE, *Sponsor*

Mr. Hyde, Tide Water Associated Oil Co., San Francisco, graduated from the University of California in 1926 with a B.S. in chemical engineering, and received an M.S. from M.I.T. two years later. From 1929 to 1946 he was general supervisor of the research and development department of the Associated Division of Tide Water. Since 1946 he has been vice president in charge of manufacturing.

R. J. ASKEVOLD

Chairman, Advisory Subcommittee

Mr. Askevold, Pure Oil Co., Crystal Lake, Ill., is also secretary of the Committee on Analytical Research. He was graduated from the University of Chicago in 1934, where he was elected to Phi Beta Kappa. After graduation he joined Pure Oil's research and development laboratories as a research chemist. For the past eight years he has been director of the analytical research and service division of the laboratories.

these same elements in trace amounts on the catalysts. Obviously, both of these programs are aimed at an ultimate understanding of which of these elements act as poisons to the catalysts used in the industry and will be invaluable in studies aimed at removal of the offenders.

3—The Subcommittee on Measurement of Physical Properties of Cracking Catalysts, headed by L. Mittelman of Tide Water Associated Oil Co., is studying the various methods used for measuring catalyst properties with the aim of selecting the best methods that are available for this purpose. This work is being conducted with the full cooperation of the companies who are manufacturing these catalysts.

4—The Subcommittee on Refinery Effluent Water Analytical Methods, headed by J. B. Rather, Jr., of Socony-Vacuum, is concerned with the development of new analytical techniques for determining minute amounts of oil, phenol and other refinery products in waste waters. This activity is a part of an intensive industry wide program aimed at the prevention of stream pollution. To date this group has developed a number of new methods for determining oil and phenols in very low concentrations.

5—The Subcommittee on Analytical Methods for Atmosphere, headed by G. R. Lake of Union Oil, is giving aid to the Committee on Disposal of Refinery Wastes in the field of de-

G. R. LAKE
Chairman, Subcommittees on Group Session Papers, and on Analytical Methods for Atmosphere

Mr. Lake, Union Oil Co. of California, Brea, Calif., holds a B.S. in chemical engineering (1929) and an M.A. in chemistry (1933) from the University of Texas. He was employed by Union Oil in 1933 as an analyst, and has also been a research chemist for the firm. He is now supervisor of the research division.

R. O. CLARK
Chairman, Subcommittee on Analysis of Cracking Catalysts

Mr. Clark, Gulf Research and Development Co., Pittsburgh, received his B.S. and M.S. degrees at the University of Nebraska, the latter in 1935. Two years later he joined Gulf to direct its microanalytical laboratory. In 1943 he was appointed head of Gulf's analytical methods section, and was promoted to head of the analytical laboratory in 1949.

termining hydrocarbons in air and expects to be useful in the activities of the API Smoke and Fumes Committee.

6—The Subcommittee on Determination of Sulfur and Sulfur Types, headed by B. J. Heinrich of Phillips Petroleum, is doing some excellent work on the determination of carbonyl sulfide, mercaptans, sulfides, disulfides, thiophenes, and other sulfur compound types. This work is being carefully coordinated with the work of API Project 48 on Sulfur Compounds.

7—The Subcommittee on Determination of Naphthenic Hydrocarbons, headed by S. S. Kurtz, Jr. of Sun Oil, has been comparing methods used in individual laboratories for determining cyclohexane and methylcyclopentane. The program is now being extended to include C_7 naphthenic hydrocarbons where agreement between laboratories and methods is not expected to be as satisfactory as was the case with the C_6 hydrocarbons.

8—The Subcommittee on Analysis of Oxygenated Compounds, headed by W. H. Jones of Esso Standard Oil, has been working on improved methods for the direct determination of oxygen. The group is now turning its attention to the determination of functional groups containing oxygen. The quantities of oxygen involved here are, in all cases, small.

9—The Subcommittee on Naphthene Hydrocarbon Type Analysis, headed by C. W. Key of Richfield Oil, will hold its first meeting in Houston in May. It is expected that they will be interested in developing analytical methods for pyrolles, pyridines, etc. in hydrocarbon mixtures.

In addition to the above, a Subcommittee on Group Session Papers, headed by G. R. Lake of Union Oil who is also Vice Chairman of the Committee on Analytical Research, has organized a Group Session on Analytical Research for the Midyear API meeting to be held in Houston, May 11 of this year. This program will include 16 papers on a variety of subjects of analytical interest. (Abstracts of all of these papers appear in this issue, beginning on pg. 725—Ed.)

Information on the activities of the committee may be obtained from either the chairman or from R. J. Askevold of Pure Oil Co. in Chicago, who is secretary of the committee.

Committee on Petroleum Products

R. C. ALDEN, *Chairman*

Mr. Alden, Phillips Petroleum Co., Bartlesville, Okla., is also chairman of the Subcommittee on Fuel Surveys of the Automotive Research Committee. He is a graduate of Lehigh University, and has been in the petroleum industry since 1920. He started with Phillips in 1925 as a senior chemist on the research staff, and was made assistant director of research in 1930, and director in 1933. He is now chairman of Phillips' research planning board.

THE Committee on Petroleum Products is concerned principally with matters pertaining to specifications, methods of test and methods of measurement for petroleum products. The Committee will serve as an advisory committee to other committees of the API and also upon request to duly authorized government agencies on matters coming within its title with particular reference to quality.

A "Glossary of Terms Used in Petroleum Refining" was published in August, 1953. This represented six years' work on the part of the Committee. The Glossary has had good reception, its sales to date having reached 1100. It is fulfilling a long felt need in this field.

Another activity of this Committee which came to fruition in 1953 was the API Technical Abstracting Service. An office and staff was set up at the API headquarters under Mr. L. C. Stork. The first issue appeared January 8, 1954. The Service abstracts about 100 chemical journals and oil periodicals. It appears weekly and covers items of interest to petroleum technologists. The abstracts are grouped by subjects rather broadly. Each issue shows some improvement in the Service so that those now appearing are very satisfactory and a great credit to Mr. Stork, his staff and the API. In spite of the high basic subscription price of $3000/year, there are now 22 subscriptions and it is indicated that this will be a successful venture.

Considerable valuable data has been accumulated during the last five years from a fellowship maintained at the Technological Institute, Northwestern University, Evanston, Illinois on the Vapor Pressure-Temperature Data sponsored by the Committee on Petroleum Products.

One of the functions of the Committee is to select API representatives on Sectional Committee Z11 on Petroleum Products and Lubricants of the American Standards Association.

This Committee has for some time been organizing a symposium on petrochemicals. This symposium will be held at the Spring meeting of the Refining Division of the API at Houston.

The Committee on Petroleum Products also has been working closely with the Diesel Engine Manufacturers' Association on mutual problems.

W. H. JONES
Chairman, Subcommittee on Analysis of Oxygenated Compounds
Mr. Jones, Esso Laboratories, Baton Rouge, La., was graduated from Alabama Polytechnic Institute in 1928 with a B.S., and received his M.S. from Louisiana State University in 1929. He was employed as a chemist by the Esso Standard Oil Co. (Louisiana Division) in Baton Rouge in 1939.

L. L. MITTELMAN
Chairman, Subcommittee on Physical Properties of Cracking Catalysts
Mr. Mittelman has been with Tide Water Associated Oil Co., Associated, Calif., for 32 years. He is a 1919 graduate of Cornell University, and joined Tide Water shortly after leaving college. He now holds the position of chief chemist with the company.

S. S. KURTZ, Jr.
Chairman, Subcommittee on Naphthene Analysis
Mr. Kurtz, Sun Oil Co., Marcus Hook, Pa., completed his B.A. studies at Harvard University in 1921, and his M.A. work in 1922. He was with Atlantic Refining Co. from 1928-35, and then joined Sun Oil as manager of the development division's chemical section. For 10 years he was manager of Sun's research laboratory at Norwood, Pa., and since 1952 has been a technical associate in the research and development department.

HARRY LEVIN
Chairman, Subcommittee on Trace Elements in Crude Oils and Catalytic Charge Stocks
Mr. Levin, The Texas Co., Beacon, N.Y., studied chemistry at Cooper Union Institute of Technology, being graduated in 1921; obtained a law degree from New Jersey Law School; and studied microchemistry at New York University in 1935-36. He is supervisor of the analytical and testing department at Texaco's Beacon Research Laboratories, and chairman of its committee on test methods.

J. B. RATHER, Jr.
Chairman, Subcommittee on Refinery Effluent Water Analytical Methods
Mr. Rather, Socony-Vacuum Oil Co., received a B.S. in chemical engineering from Lehigh University in 1932. He joined Magnolia Petroleum Co., a Socony-Vacuum affiliate, in 1935, and was transferred in 1937 to Socony's laboratories in Brooklyn, N.Y. He is assistant director of the technical service department, and supervisor of the inspection and fuels section.

B. J. HEINRICH
Chairman, Subcommittee on Determination of Sulfur and Sulfur Types
Mr. Heinrich, Phillips Petroleum Co., Bartlesville, Okla., received an M.S. in analytical chemistry from the University of Oklahoma in 1930. From 1937 until he was employed by Phillips in 1943 he taught chemistry. He has done work toward a Ph.D. at both Oklahoma and the University of Michigan, and since 1945 has been chief of the analytical section of Phillips' research department.

W. R. ARGYLE, *Sponsor*
Mr. Argyle, Sinclair Refining Co., New York, was graduated from the University of Utah. When he joined Sinclair he was put in charge of fuel and utilities for all of the company's refineries. In 1924 he became superintendent of the Marcus Hook, Pa., refinery and remained there until 1943. From then until 1945 he served in Washington with the PAW. Upon returning to Sinclair he became assistant manager of refining, and is now vice president for refining and a director of the company.

A. E. MILLER
Chairman, Glossary Subcommittee
Mr. Miller, Sinclair Refining Co., New York, is also chairman of the Advisory Committe's Information Subcommittee. He received his B.S. in Chemistry from Pennsylvania State College in 1912, and then joined Gulf Refining Co. He has been with Sinclair since 1918, and assistant to the vice president, research and development, since 1942. He has spent a number of years in Europe for Sinclair, gathering technical data.

J. C. GENIESSE
Chairman, Subcommittee on Viscosity Standards
Mr. Geniesse started with The Atlantic Refining Co., Philadelphia, after obtaining a Ph.D. in chemical engineering at the University of Michigan. For a time he was concerned with fuel and lubricant tests and fuel production from heavy petroleum products. Subsequently he became divisional director of research in heavy oils in the research and development department, and later was made director of the application research division of the department.

H. W. FIELD
Chairman, Subcommittee on Central Abstracting Service
Mr. Field, Atlantic Refining Co., Philadelphia, received his B.S. in 1928 from the U. of Pennsylvania. He started with Atlantic as a junior engineer, and after a series of promotions became assistant manager in the research and development department in 1940. He was elected a director in 1946, appointed general manager of the department in 1947 and vice president in charge of research and development in 1949.

K. M. WATSON
Chairman, Subcommittee on Vapor Temperature-Pressure Relationships
Mr. Watson, Pure Oil Co., Crystal Lake, Ill., is also chairman of Project Advisory Committee No. VII of the Smoke and Fumes Committee. He received his B.S., M.S. and Ph.D. (1929) from the U. of Wisconsin, joined UOP in 1931, was research director there from 1935-41, spent a year with Gulf Oil, and returned to his alma mater in 1942 as a research professor. In 1952 he joined Pure as director of research.

J. G. RAYMOND
Chairman, Study Group on Mechanics
Mr. Raymond, Sinclair Refining Co., New York, was graduated with a B.S. from Michigan State College in 1928, and in 1931 received a degree in library science from Columbia University. He has been Sinclair's Librarian since 1946.

B. R. SIEGEL (not shown)
Chairman, Subcommittee on Octane Precision
Mr. Siegel is with Sinclair Refining Co., Harvey, Ill. No photograph available.

Committee on Disposal of Refinery Wastes

J. H. EASTHAGEN, *Chairman*

Mr. Easthagen is also chairman of his committee's Coordinating Subcommittee. He was graduated by the Colorado School of Mines in 1928 with a degree in petroleum engineering. Next he was employed by Standard Oil Co. of California at the El Segundo refinery. In 1944 he transferred to the California Research Corp. when it was formed, and in 1945 he moved to the Richmond Laboratories to take charge of technical services, research and certain development work. He is now senior research engineer.

THE Committee on Disposal of Refinery Wastes has the responsibility of collecting, summarizing, and publishing in manual form technical information that will be of assistance to refiners in selecting efficient and effective methods for handling and disposing of waste materials.

Since 1951 the committee has been engaged in a complete revision and reorganization of the Manual on Disposal of Refinery Wastes. The manual has been divided into five volumes, and since 1951 four of the five volumes have been revised, expanded, and published. The five volumes and their status are as follows:

Volume I—"Waste Water Containing Oil"—The fifth edition of this volume was published in March 1953.

Volume II—"Waste Gases and Particular Matter"—The fourth edition of this volume was issued in May 1952.

Volume III—"Chemical Wastes"—The second edition of this volume was published in 1951.

Volume IV—"Sampling and Analysis of Waste Water"—The first edition of this volume was published in 1953.

Volume V—"Sampling and Analysis of Waste Gases and Particular Matter"—The first edition of this volume is nearing completion and should be published in 1954.

The committee is currently actively engaged in preparing material for the revision and expansion of Volumes I, II, and III.

The committee is currently sponsoring four research projects. One research project, contracted to the Academy of Natural Sciences in Philadelphia, concerns the applicability of a certain bio-assay method to natural bodies of water typical of those into which petroleum refineries discharge waste. Work under this contract was initiated in the Spring of 1953 and will probably cover about three years.

A second project, contracted to the Boyce Thompson Institute, is a cooperative project sponsored by a group of industries interested in determining the effects of long time exposure to extremely low concentration of fluorides in the atmosphere on vegetation. This project was initiated in 1951 and will probably run for an additional two years.

In 1953 two additional projects were initiated by the committee. The first of these is a project to evaluate critically the currently available data on the acute and chronic toxicity for man and animals of selected chemical pollutants found in waste streams from petroleum refineries. A new subcommittee has recently been formed to act as project advisory group in establishing and carrying out the project.

The second new research project concerns the collection, evaluation, and assembly in a comprehensive and publishable form of available information on the subject of Removal of Dust and Particular Matter from Waste Gases. A new subcommittee has recently been set up and assigned to act as an advisory group in establishing and carrying out the details of this project.

The various subcommittees of the committee are currently giving attention to the following subjects:

1—The evaluation of gas flotation as a means of removing oil from waste waters.

2—The investigation of economical methods for handling and disposing of oily sludges and clays.

3—A study of the relative merits of circular and rectangular oil-water separators.

4—The development of the design of an all-purpose incinerator.

5—The biological treatment of wastes.

6—Treatments for phenolic-type wastes.

7—Chemical oxidation of organic-type wastes.

The results from the activities of these various subcommittees will be used in the expansion of appropriate volumes of the Manual on the Disposal of Refinery Waste.

G. A. DAVIDSON, *Sponsor*

Mr. Davidson, Standard Oil Co. of Calif., San Francisco, received his B.S. from the University of California in 1921 and was then employed by California Standard as a chemist in research and development. He became superintendent of the refinery at El Segundo in 1933. In 1937 he was assigned to the home office as assistant to the general manager of the manufacturing department, becoming assistant general manager in 1943, then assistant vice president. The company elected him vice president in 1944.

W. C. DOUCE

Chairman, Subcommittee on Waste Gases and Dusts

Mr. Douce was employed by Phillips Petroleum Co., Bartlesville, after his graduation from the University of Kansas in 1942, and worked in plant operations and refinery process engineering. In 1945 he was made technical adviser in the patent department. After three years he returned to refining, as staff administrator, and in 1950 became coordinator of pollution abatement and product-los control work.

R. J. AUSTIN

Chairman, Subcommittee on Chemical Wastes

Mr. Austin, Standard Oil Co. (Ind.), Whiting, received his bachelor's degree from the University of Kentucky in 1933, and a year later his M.S. in physical chemistry. In 1936 he joined the research department of Indiana Standard. He is currently working in the technical service division of the research department as a group leader on problems relating to refinery waste disposal and atmospheric pollution.

L. C. BURROUGHS

Chairman, Biological Project Subcommittee

L. C. Burroughs, Shell Oil Co., New York, is a graduate of the University of Illinois. He joined Shell in 1925 as a chemist at the Wood River, Ill., refinery. Later he worked in the manufacturing department of the company's head office. In 1942 he became assistant superintendent of the Houston refinery and held that position until he returned to Shell's head office in 1946 as assistant to the vice president.

W. H. BARCUS
Chairman, Fluoride Project Subcommittee
Mr. Barcus, Sun Oil Co., Marcus Hook, Pa., was graduated from Swarthmore College in 1927. Shortly afterward he was employed by Sun as a chemist, and two years later became a chemist and chemical engineer in the development laboratory. In 1936 he was appointed chief of the chemical engineering section of the development division, and since 1948 he has been manager of the development laboratory of the research and development department.

RANDLOW SMITH
Chairman, Dust Collector Project Subcommittee
Mr. Smith, The Texas Co., New York, was graduated from the California Institute of Technology with an M.S. in 1941 and joined The Texas Co. in New York City shortly afterward. He became a senior engineer before leaving for military service in 1944. Returning to the company in 1946, he continued his work in the design of waste disposal works, alkylation units and miscellaneous stabilizers.

J. A. FOWLER
Chairman, Sludge and Spent Clay Disposal Project Subcommittee
Mr. Fowler, Sinclair Refining Co., East Chicago, Ind., is a 1935 graduate of the University of Texas, where he received a B.S. in chemical engineering. He was employed by Gulf Oil Corp. in various laboratories and grease plants until he entered military service in 1942. In 1945 he joined Sinclair in the laboratory department and was later transferred to the technical department.

D. G. STEVENS
Chairman, Water Quality Criteria Project Subcommittee
Mr. Stevens, Standard Oil Co., (Ohio), Cleveland, was graduated as a chemical engineer by Syracuse University in 1938. He spent four years with Standard of New Jersey at Aruba, N.W.I. as a process engineer before joining Ohio Standard in 1941. During the past several years he has been active in process engineering and operation of waste disposal facilities. Currently he is chief of technical service.

W. H. LANG
Chairman, Incinerator Design Project Subcommittee
Mr. Lang, Standard Oil Development Co., received a B.S. from Washington and Jefferson College in 1934, an M.S. from Iowa State University in 1938, and a Ph.D. from the University of Iowa in 1940. He has been a sanitary engineer for Pennsylvania, chief chemist and bacteriologist for Newport News, and an associate edito rof *Water Works Engineering*. He is currently a consultant on pollution for SOD.

RAY C. ADAMS
Chairman, Subcommittee on Oil-Water Separation
Mr. Adams is with Magnolia Petroleum Co., Beaumont, Texas. No photograph or biographical data available.

L. MITTELMAN
Chairman, Subcommittee on Sampling and Testing
(see photo, Committee on Analytical Research)

Analytical Research Sessions

Here are the abstracts of 16 papers on a wide range of newly developed methods of testing

AS in the past, the broad scope of activities of the API Refining Division's Committee on Analytical Research is reflected in the two technical sessions on that subject at this year's mid-year meeting.

The 16 papers scheduled for presentation represent one means whereby the work of the Committee and its sub-committees is brought to the attention of the industry. Topics to be covered in the discussions include the following:

Micro techniques for distillation and for trace quantities of metals and non-metals; several spectographic procedures; tests for mercaptan sulfurs and for hydrogen sulfide in the air; procedures for testing gasoline, grease, crankcase drainings, and other products.

A detailed report on the activities of the Analytic Research Committee itself appears in this section on p. 720. The complete program for the two sessions on Analytical Research, both of which will be held Monday, May 10, appears on p. 705.

C. E. Headington, Atlantic Refining Co., Philadelphia, and chairman of the Analytical Research Committee, will preside over the morning session; and R. J. Askevold, Pure Oil Co., Crystal Lake, Ill., and secretary of the committee, will preside over the afternoon session.

Abstracts of each of the 16 papers follow.

COORDINATING GROUP OPERATIONS

"Coordinating the Operations of a Petroleum Research Analytical Group," by W. C. Schaefermeyer and E. S. Smith, Union Oil Co. of California, research and process department, Brea, Calif.

• Petroleum research progress and costs depend heavily upon the efficiency of the analytical services available. The analytical group at the Union Oil Co. of California Research Center has found that many devices and practices developed originally to increase the efficiency of business offices may be used profitably for the coordination of laboratory operations. Punched cards, high-speed accounting machines, and a duplicator which uses a beam of infrared energy are only a few of the devices which now relieve scientists and technicians of paper work and supply supervisory personnel with information they need to direct laboratory operations efficiently.

MERCAPTAN SULFUR IN GAS AND LIQUID HYDROCARBONS

"A Simplified Amperometric Method for Determining Mercaptan Sulfur in Liquid and Gaseous Hydrocarbons," by M. D. Grimes, J. E. Puckett, B. J. Newby, and B. J. Heinrich, Phillips Petroleum Co., research division, Bartlesville, Okla.

• Often it is important to know the concentration of the various types of sulfur compounds in refinery streams and petroleum products.

The work reported in this paper was undertaken as a result of the need for an accurate, fast method for the determination of mercaptan sulfur in all kinds of refinery streams and in finished petroleum products. A method is described for its determination in either liquid or gaseous hydrocarbons. The amperometric apparatus is inexpensive and portable. Data presented indicate that the method is satisfactory for specification

Mr. Schaefermeyer

Mr. Smith

testing. An analysis for the mercaptan content of a sample of jet fuel can be made in less than 10 min. The analysis of a sample of liquefied petroleum gas requires a slightly longer period because of the processing of the sample before the amperometric titration.

MINIATURE COLUMN DISTILLATION

"Analytical Distillation in Miniature Columns—I: Equipment and Operation," by J. C. Winters and R. A. Dinerstein, Standard Oil Co. (Indiana), research department, Whiting, Ind.

• A fraction of an ounce of liquid can be separated into dozens of individual components in new miniature distillation equipment. Many research experiments produce as little as a tablespoonful of material. Such tiny quantities must be further separated by distillation into many smaller fractions, each containing only a few drops. These fractions can then be identified by modern microanalytical methods, such as spectroscopy.

To distill such small samples, special controls and instruments are needed so that materials which boil at almost the same temperature can be separated. For example, the electric power which supplies the heat must be controlled within a few thousandths of a volt. It may take as long as a week to distill 2 oz. in continuous routine operation.

TRACE METAL TECHNIQUES

"New Techniques for Analyzing Mixtures of Trace Metals," by R. M. Sherwood and F. W. Chapman, Atlantic Refining Co., Philadelphia, Penna.

• Today's high-octane gasoline, as well as many chemicals derived from petroleum, is made by catalytic processes. In such cases the catalyst is introduced into the process to steer the chemical reactions in the direction of making the desired product. However, the minute quantities of metals which are in petroleum frequently poison this catalyst, and make it unable to do its job. This paper describes methods for measuring the amounts of many of these metals in petroleum when they are present in concentrations of only a few parts of metal per million parts of oil. The use of such methods should help the petroleum refiner to discover which of the many metals present poison his catalyst, and should also help him to solve the problem of how to remove them from the oil.

Mr. Grimes

Mr. Puckett

HYDROGEN SULFIDE IN AIR

"An Analyzer-Recorder for Measuring Hydrogen Sulfide in Air," by E. B. Offutt, American Thermometer Division of Robertshaw-Fulton Controls Co., St. Louis, Mo., and L. V. Sorg, Standard Oil Co. (Indiana), Sugar Creek, Mo.

• Hazards in the petroleum industry have been overcome one by one. Science and engineering have pitted their "know-how" against the inherent hazards of refinery operations. Hydrogen sulfide, a deadly gas, is one such hazard. It is one of the ingredients of crude oil, and it also arises in refining operations by the breakdown of sulfur compounds. Recognizing the need for an instrument which would detect and record the presence of this deadly gas, a team of Standard Oil (Indiana) researchers developed such a machine. It also sounds an alarm when the amount is above the safe limits of 20 ppm. The machine already has proved its worthiness in field tests made at several of Standard's refineries. Unsuspected hazardous areas have been revealed, and corrective measures have been taken.

Although the first models of the machine operate in the range from 0 ppm to 100 ppm of hydrogen sulfide in air, it is versatile enough to be adapted for control of gas streams in sulfur-recovery systems. The instrument uses a special film prepared by coating blank 16-mm. motion-picture film with a chemical which becomes black in the presence of hydrogen sulfide. A sample from the air under test is pumped continuously through an exposure hood. The hydrogen sulfide reacts with the film coating to form a stain. A light beam through the stained film falls on a photoelectric cell which generates an electrical current. The current operates a conventional electronic recording device.

MICRO-DISTILLATION

"Micro Distillation Methods for the Analysis of Petroleum," by A. R. Javes, C. Liddell, and W. H. Thomas, Anglo-Iranian Oil Co. Ltd., Sunbury-on-Thames, Middlesex, England.

Mr. Newby

Mr. Heinrich

• Minute quantities of crude oil, extracted by solvent from cores removed during drilling, give the first indications of the quality of oil in new structures being penetrated. The sample of crude oil obtained is usually too small to fractionate and, as a result, it is not possible to obtain full analytical details on the crude. Consequently, it was found necessary to devise an apparatus which would do the job. This paper describes a piece of equipment which can operate at atmospheric pressure or under vacuum, and fractionate a quantity as small as 0.8 ml.

SMALL SCALE RVP DEVICE

"A Reduced-Scale Reid Vapor-Pressure Apparatus," by R. L. LeTourneau, Julian F. Johnson, and W. H. Ellis, California Research Corp., Richmond, Calif.

• The volatility of gasolines is an important property, and one which frequently is measured in connection with studies of the vapor-lock and starting characteristics of gasolines. Normally about a pint of sample is required to make this measurement. California Research Corporation has developed an apparatus which requires only 3 ml. of sample. This is about 1% of the regular sample. This will permit measurements to be made on samples withdrawn directly from the carburetor or fuel lines of engines. Information so obtained will be useful for tailoring gasolines for specific climates and for design of fuel systems.

WATER IN ACETALDEHYDE

"The Determination of Water in Acetaldehyde by Infrared Spectroscopy," by J. A. Favre, James P. Butler, and B. J. Heinrich, Phillips Petroleum Co., research division, Bartlesville, Okla.

• The amount of water in acetaldehyde is a critical factor for the control of the reaction rates of chemical processes which use acetaldehyde. Standard methods, such as Karl Fischer's, are not suitable for this analysis. An infrared method is presented which covers the concentration range of 0.1 to 0.4 wt.-% of water in acetaldehyde. Acetalydehyde boils at room temperature, and readily absorbs water from the atmosphere. This paper presents special handling and blending instructions for the preparation of synthetic blends used in the calibration of the

Mr. Winters

Mr. Dinerstein

Mr. Sherwood

Mr. Chapman

Mr. Offutt

Mr. Sorg

Mr. Javes

Miss Liddell

Mr. Thomas

Dr. LeTourneau

Mr. Johnson

Mr. Ellis

infrared instrument. The accuracy of this method is plus or minus 0.01 wt.-% in the range covered.

REVIEW OF TEL TESTS

"Methods for the Determination of Tetraethyllead in Gasoline—A Review," by C. M. Gambrill and Sue A. Gendernalik, Ethyl Corp., Research Laboratories, Detroit, Mich.

• The increasing importance of tetraethyllead to the petroleum industry has prompted considerable research aimed at the development of more accurate and less time-consuming analytical methods. The numerous methods reported in the literature for the determination of tetraethyllead in gasoline are reviewed. Obviously it is impossible to expect one method to serve the needs of all the various laboratories required to make the analysis. The advantages and disadvantages of the various methods are discussed in an attempt to acquaint the reader with their overall application.

With the introduction of instrumental methods, it has been possible to reduce the elapsed time for an analysis from 7 hrs. to a matter of minutes without sacrificing accuracy. This paper presents in one source all the references to methods, for the analyses of gasolines for tetraethyllead, which have been published to the present time.

PAN IN NEW AND USED OILS

"Determination of Phenylalpha-naphthylamine (PAN) in New and Used Oils (A Colorimetric Method)," by W. S. Levine and W. A. Marshall, Socony-Vacuum Laboratories, Brooklyn, N. Y.

• In use, oils tend to oxidize. Hence special compounds are added to them to retard oxidation. One such compound is phenylalpha-naphthylamine (PAN), an aromatic amine. To test its effectiveness in oils in the laboratory and for plant use, a method to determine the presence and concentration of PAN is needed. This paper describes such a qualitative and quantitative procedure. Results are accurate enough for control of oil blending, and for examining used oils.

A small amount of oil is dispersed in acetone, and a reagent is added. The reagent forms a bluish-purple solution with the PAN, and the intensity of the color is measured with a colorimeter. The PAN content of an oil is read off a graph which relates the color intensity to PAN concentration. Also described are the factors which affect the intensity and stability of the color. The precision of the method for samples which contain up to 0.1% of PAN is estimated to be approximately plus or minus 10%. The procedure is rapid. One sample can be analyzed in 18 to 20 min., and approximately 25 analyses can be made in an 8-hr. period. If other aromatic amines are present, they may cause high results.

COPPER IN CRANKCASE DRAININGS

"Spectrochemical Determination of Copper in Crankcase Drainings," by C. R. Hodgkins and John Hansen, Esso Laboratories Research Division, Standard Oil Development Co., Linden, N. J.

• The copper in a single penny dispersed in about 700 qt of oil. illustrates the 5 parts of copper in a million parts of oil which it is possible to determine by the spectrographic method described. The analysis can be made on as little as one thirtieth of an ounce of used lubricant, and can be completed in less than 1 hour after the sample has been taken.

The copper content of the oil in the crankcase of laboratory engines used to evaluate lubricants can be related to the loss in weight of the copper-lead bearing in the test engine. By analyzing samples taken at fixed time intervals during the test, the engineer can calculate the amount of bearing weight loss, and can establish when the loss occurs, without the necessity of taking the engine apart to remove the bearing for weighing.

TRACE METALS ON CATALYSTS

"The Determination of Trace Amounts of Iron, Nickel, and Vanadium on Catalysts by X-Ray Fluorescence," by G. V. Dyroff and P. Skiba, Esso Laboratories Research Division, Standard Oil Development Co., Linden, N. J.

• Everyone is familiar with the use of X-rays by physicians for diagnosing various bodily ills. Scientists at the Esso Laboratories of the Standard Oil Development Co. are utilizing these same X-rays to diagnose some "ills" of a giant "cat cracker."

By combining new "high-powered" tools such as X-rays and Geiger tubes with common table salt (in the form of a large single crystal), very rapid and precise determinations of minute amounts (as little as 20 particles in a million) of iron, nickel, and vanadium can be made.

Inasmuch as small amounts of these metals on the catalyst have a marked effect on the processing of oils in a catalytic cracking unit, rapid methods of analyses are almost a necessity. Accurate analyses of these catalyst samples by means of X-rays can be carried out in 15 min as compared to several hours by usual methods.

MICRO QUANTITIES OF NON-METALS

"Non-metal Analysis of Micro Quantities of Solids by Means of the Emission Spectrum," by E. L. Gunn, Humble Oil and Refining Co., refining technical and research divisions, Baytown, Texas.

• In present-day manufacturing technology the role which minute amounts of substances play in influencing the course of chemical reactions is becoming of increasing importance. In petroleum processing, for example, the occurrence of trace elements may have a profound effect upon the course taken by a specific reaction—thus influencing the amount of valuable product recovered in the process. The detection and identification of minute micro quantities of solids often provides a valuable clue to the researcher for ferreting out reasons for the course taken by a process which he is investigating. For rapid and precise detection of these traces the best analytical tools available are required. This paper describes a technique whereby certain non-metals such as sulfur and chlorine can be determined in micro amounts of solids by means of an emission spectrograph.

In principle, the detection of a non-metal in a material by the emission spectrum consists in subjecting the material to the impact of a powerful high-voltage spark discharge which causes light of a characteristic nature to be emitted. By measuring this light, the identity of the non-metal, as well as its amount in the material, is determined. The production of the light spectrum in non-metals has its points of difficulty, and some of these are considered.

The emission spectrum has been used to determine as little as 1% of sulfur and

Mr. Favre

Mr. Butler

Mr. Gambrill

Miss Gendernalik

Dr. Levine

Mr. Marshall

Mr. Hodgkins

Mr. Hansen

Mr. Dyroff

Mr. Skiba

Mr. Gunn

Mr. Key

chlorine in micro solids which weigh 0.0003-ounce. This sample amount would be very difficult and time-consuming to analyze by other methods; but the analysis may be performed in approximately 2 hr. by the spectrum method. Thus the method is especially useful in case the sample amount is extremely small. It is applicable to ash matter, deposits, surface films, paints, erosion products, precipitates, and similar solids which often require identification in the refinery laboratory.

SPECTRO METHOD FOR GREASES

"Spectrographic Method for Analyzing Lubricating Greases," by C. W. Key and G. D. Hoggan, Richfield Oil Corp., Wilmington, Calif.

• This direct spectrographic method for analyzing lubricating greases was developed in order to provide a rapid and accurate method by which the metallic elements in these petroleum products could be determined. Chemical and spectrographic methods based on prior ashing of such samples require excessive periods of time. Because of the length of time required to complete these analyses, they do not provide the necessary controls for the production and handling of such materials. Therefore, it was believed that a rapid spectrographic method would enable the processors and developers of lubricating grease to maintain better control over the product.

For many years the manufacture of grease has been considered an art rather than a science; however, recent developments which require that lubricating greases meet more severe operating conditions demand that the compounding material be controlled with more scientific knowledge. The additions of metallic soaps to lubricating oils so as to produce greases with waterproof, extreme-pressure, high-temperature, anti-foam, anti-corrosion, and other characteristics are common practice. Because of the special characteristics which metallic soaps impart to lubricating greases, it is highly desirable that the addition of such compounds be precisely controlled; otherwise uniformity of product will not be obtained, nor will the desired characteristics be imparted to the final grease.

Spectrographic methods for determining metallic constituents in lubricating oils have been reported by several investigators. It was believed that the same principle could be utilized in the determination of similar metals in greases, provided the greases could be taken into and maintained in solution. An investigation of several solvents for greases disclosed that the greases could be taken into solution, and could be delivered to the arc spark stand of an emission spectrograph. Operating variables of the spectrograph were determined; and it was found that, by employing a high-voltage spark discharge, the metallic elements could be sufficiently energized to create spectral lines which could be recorded on 35-mm film, and could then be compared with similar lines deposited from known concentrations of internal standards. This method then provided an accurate and reliable means of determining the metallic constituents in lubricating greases. By using this method, research and development laboratories and lubricating-grease plant engineers have a means whereby metallic elements may be determined as a process is under way. From these data modifications may be made, when necessary, during the processing and compounding operations—thus enabling the production of scientifically controlled and developed grease.

This method requires between 50 and 60 min. to complete the analyses of a single sample; whereas to obtain the same data by conventional chemical analyses may require as long as 40 hours. In this way modern scientific instrumental analyses make possible the scientific production of superior lubricants for high speeds and pressures, close tolerances, high and low temperatures, and other severe requirements of present-day machines.

SPECTRO ANALYSIS OF PRODUCTS

"Spectrographic Analysis of Petroleum Products and Related Materials," by L. L. Gent, C. P. Miller, and R. C. Pomatti, The Texas Co., Beacon, N. Y.

• In recent years many of the slower chemical methods for quantitative analysis of metals have been replaced by instrumental spectrographic methods. The principle of these latter procedures is that the intensity of light emitted by metals when they are burned in an electrical arc is proportional to their concentration in the sample.

The unique technique described by these authors is the sample preparation whereby the sample to be analyzed is weighted onto a relatively large amount of graphite powder contained in a crucible. If it is an oil or grease, the sample is burned, and the residue is mixed thoroughly. Portions of this are placed in cratered graphite electrodes and burned in an electrical arc. The light rays from the arc, in both quality and quantity, are characteristic of the various metals, and are measured by use of a photographic plate and a densitometer.

The method is applicable to a wide variety of samples such as oils, greases, additive concentrates, engine materials, and anti-freeze. It can also be applied advantageously to relatively small samples, as for example, the few milligrams of grease remaining in a used ball bearing.

SPECTRO ANALYSIS OF ASH RESIDUES

"Application of the Logarithmic Sector to Quantitative Spectrographic Analysis of Petroleum-Ash Residues," by E. B. Childs and J. A. Kanehann, Socony-Vacuum Laboratories, Brooklyn, N. Y.

• One of the most interesting tools used by chemists is the emission spectrograph. This instrument makes possible quantitative analysis of many elements in a sample at the same time. This results in a considerable saving of time and expense. Usually the amount of an element present is determined by measuring line intensities on a photographic plate with an expensive densitometer.

This paper shows that quantitative spectrographic analyses of petroleum-ash residues may be done without a densitometer. A logarithmic-sector disc is rotated in the light beam from the burning sample. Line intensities are estimated by measuring line lengths with a simple hand magnifier. Other spectrographic techniques remain the same, including the use of an internal standard (indium).

Precision generally is not quite so good as when the densitometer is used. However, in many cases, precise analysis is unnecessary. The application of this method will save about one-half of the time usually spent on quantitative spectrographic analyses. Because a densitometer is not needed, the procedure may be attractive to smaller laboratories.

Mr. Hoggan

Mr. Gent

Mr. Miller

Mr. Pomatti

Mr. Childs

Mr. Kanehann

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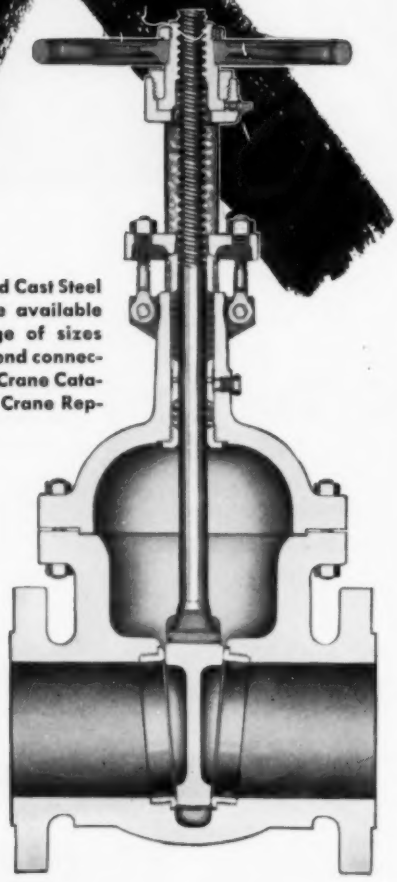

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PETROLEUM PROCESSING

MAY 1954

Petrochemical Processing Section

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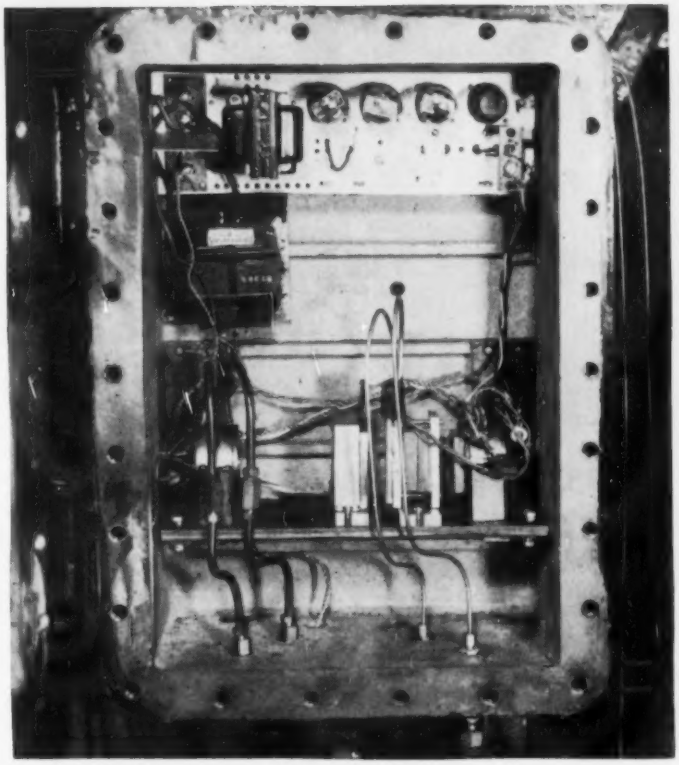

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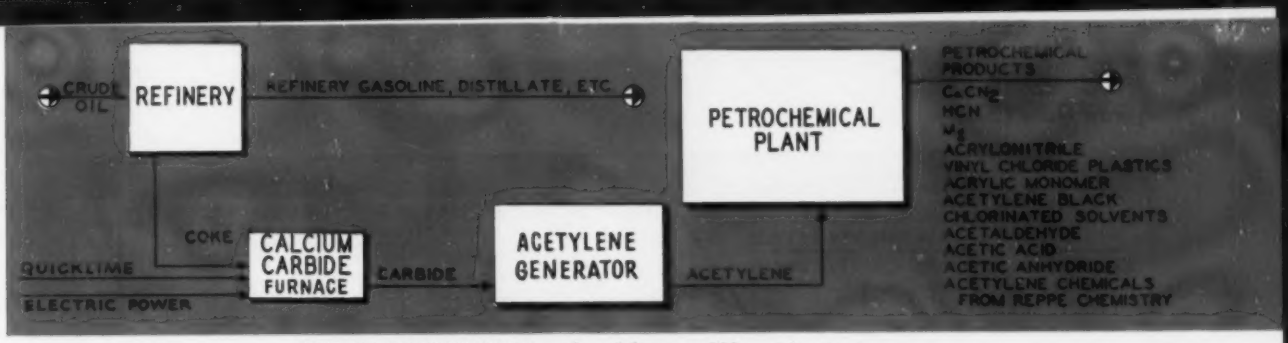


COKE TO PETROCHEMICALS — via calcium carbide and acetylene

REFINERY COKE—

A New Source of Petrochemical Profits

REFINERS have long considered installation of a coking unit as a profitable way in which to dispose of residual fuel—converting the heavy oil to petroleum coke and catalytic cracking feed stock. Such a unit increases the value of products from each barrel of crude, and at the same time removes the limitations on crude runs imposed by unsalable fuel oil.

A big drawback to coking, however, has been finding a suitable market for it, even though, as one refiner says, "it's a lot easier to pile the stuff up in the back yard than it is to find storage for excess fuel oil."

Today a solution to this problem and an entirely new field of profits are opened up with the possibility of installing additional facilities to process the coke to petrochemicals.

Acetylene, the most versatile of petrochemicals, can be made by first converting coke to calcium carbide, which then yields the acetylene on hydrolysis. Such a step compounds the profits from coking in two ways:

1—It assures the refiner a steady market for his coke, whether the conversion to carbide and acetylene is carried out in his own plant or by another firm to which he sells his coke.

2—It permits him, if he elects to convert the coke himself, additional profits from the wide variety of petrochemicals which can be made from the flexible acetylene building block.

Even the small refiner can get into the picture. The figures in the report which follows are based on the coke output from a 40,000 b/d refinery, but the smaller operator can run a heavier crude to a high yield of coke, or several refiners between them might supply the coke for a central carbide and acetylene plant.

The process involved in converting coke to calcium carbide is relatively simple. Raw coke of suitable size is charged with quicklime to an electric furnace, where it is converted to the carbide according to the following reaction:

$$CaO + 3C \rightarrow CaC_2 + CO$$

The molten carbide is removed from the furnace and poured into ingots. These, when solid, are crushed to a size suitable for charging to an acetylene generator, or for sale to a chemical manufacturer.

Equipment required, in addition to the coking unit, consists essentially of coke preparation facilities (drying, if the coke is wet, and crushing to a size of less than 1 in.), a kiln for preparing quicklime, the carbide furnace, molds for casting the carbide in ingots, a crusher to break up the ingots, and suitable storage and material handling facilities.

Beyond that, it depends on how far you want to go. You can sell the carbide to a chemical manufacturer. You can convert the carbide to acetylene and sell the acetylene via pipe line to nearby chemical plants. You can process the acetylene yourself to any number of chemicals. Or you can do all three.

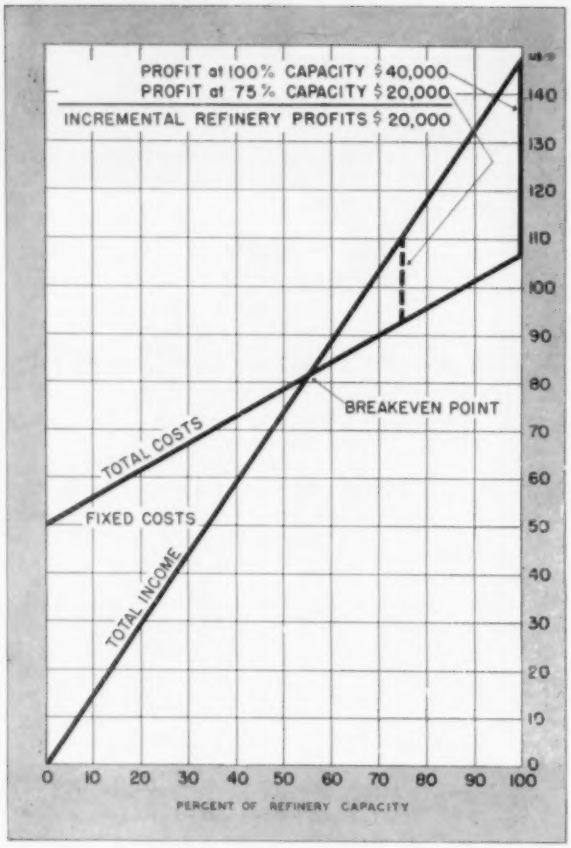
Biggest operating cost in the conversion of coke to carbide is electric power. Carbide furnaces require about 2900 KWH per ton of carbide, which in turn yields about a third of a ton of acetylene.

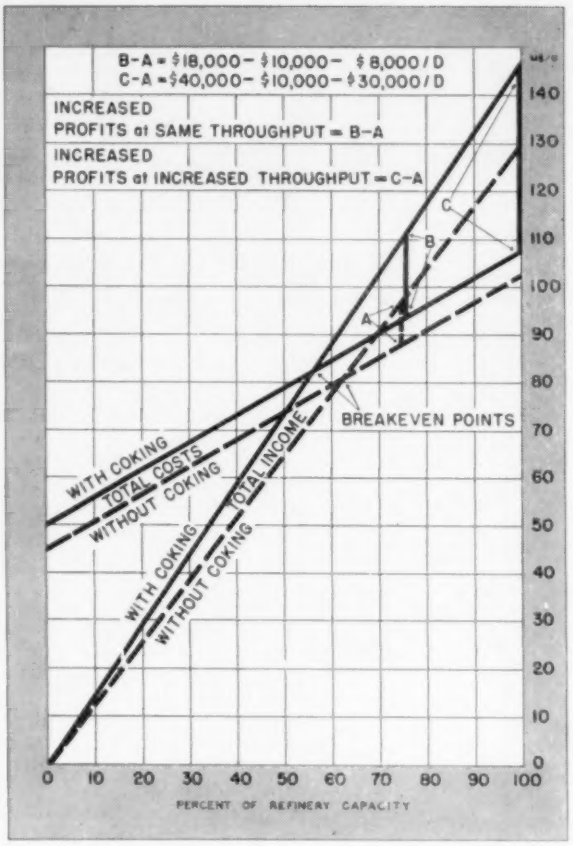
Power costs, possibly, can be reduced to reasonable levels by operating the furnace at below capacity during peak power demand periods and above capacity during off-peak periods when power can be bought at a lower price.

It might also be appropriate to point out that utilities are frequently interested in adding additional generating capacity and selling it at a favorable price if they can be assured of a steady and firm demand from one source.

An interesting sidelight is the fact that the off-gas from the carbide furnace contains an appreciable amount of carbon monoxide. This gas might conceivably be used with excess hydrogen to provide synthesis gas for an additional and entirely different group of petrochemicals.

● New frontiers in petrochemicals were outlined by three petroleum technologists at the regional meeting of the Western Petroleum Refiners Assn. in Beaumont, Texas, Feb. 11-12. The highlights of what they suggested are given above; the major portions of their report on "Petrochemical Profits from Refinery Coke" appear on the following pages.





FIGS. 1 and 2 — Typical profit pictures for a 40,000 b/d refinery. Fig. 1 (left) shows incremental profit made by a refinery with coking when able to operate at full capacity. Fig. 2 (right) shows profit picture with and without coking and increased profits possible with coking at 75% capacity and at 100% capacity which coking permits

Petrochemical Profits from Refinery Coke

Coking Itself Increases Your Refinery Profits

Fig. 1 is a typical profit picture for a 40,000 b/d refinery. The difference between total income and total costs represents *profit* or *loss*. The break-even point in this case is about 55% of full capacity. Crude runs may be limited to 75% of capacity by a restricted market for fuel oil, and gross profit before taxes at 75% of capacity is $20,000 per day.

The installation of a coking unit permits operation at full refinery capacity, or at gross profits of $40,000 per day. The profit from the incremental crude capacity is therefore $20,000 per day. Of course, this analysis assumes that there is an adequate market for the extra LPG, gasoline, and coke produced. The petroleum coke market can be assisted by converting coke to calcium carbide and manufacturing acetylene or other chemicals from that. The profit shown above is profit from operation of the refinery alone and does not include any petrochemical profits.

Another picture perhaps more in tune with present times when the object may not be to run more crude but to increase the value of the refined products, is presented in Fig. 2. The dotted lines represent a profit picture for a refinery which has no coking unit and which is limited by the fuel oil market to 75% of capacity. The profits in this situation amount to $10,000 per day. The break-even point is 61%.

By the installation of a unit to make coke, the total costs are more but the total income is also more since the products are upgraded in value. At the same crude throughput of 75% of capacity, the profits have been increased to $18,000 per day or a profit increment of $8,000 per day. The break-even point has been lowered to 55% of capacity. However, if greater product values and greater crude runs are both desired, the refinery at 100% of capacity will yield a profit of $40,000 per day or an incremental profit of $30,000 per day over the previous picture before the coking unit was operating.

From these analyses, it may be shown that the refiner can profit greatly from a coking unit providing he can be assured of a steady market for his coke.

There are several ways in which a refiner may profitably dispose of coke, and the chief way, besides fuel, has been to sell the coke to the aluminum industry for electrodes. A one-step process for converting fuel oil as such to electrode coke of a specific gravity of 2.0 consists of coking the fuel oil in a calcining furnace, or broad oven

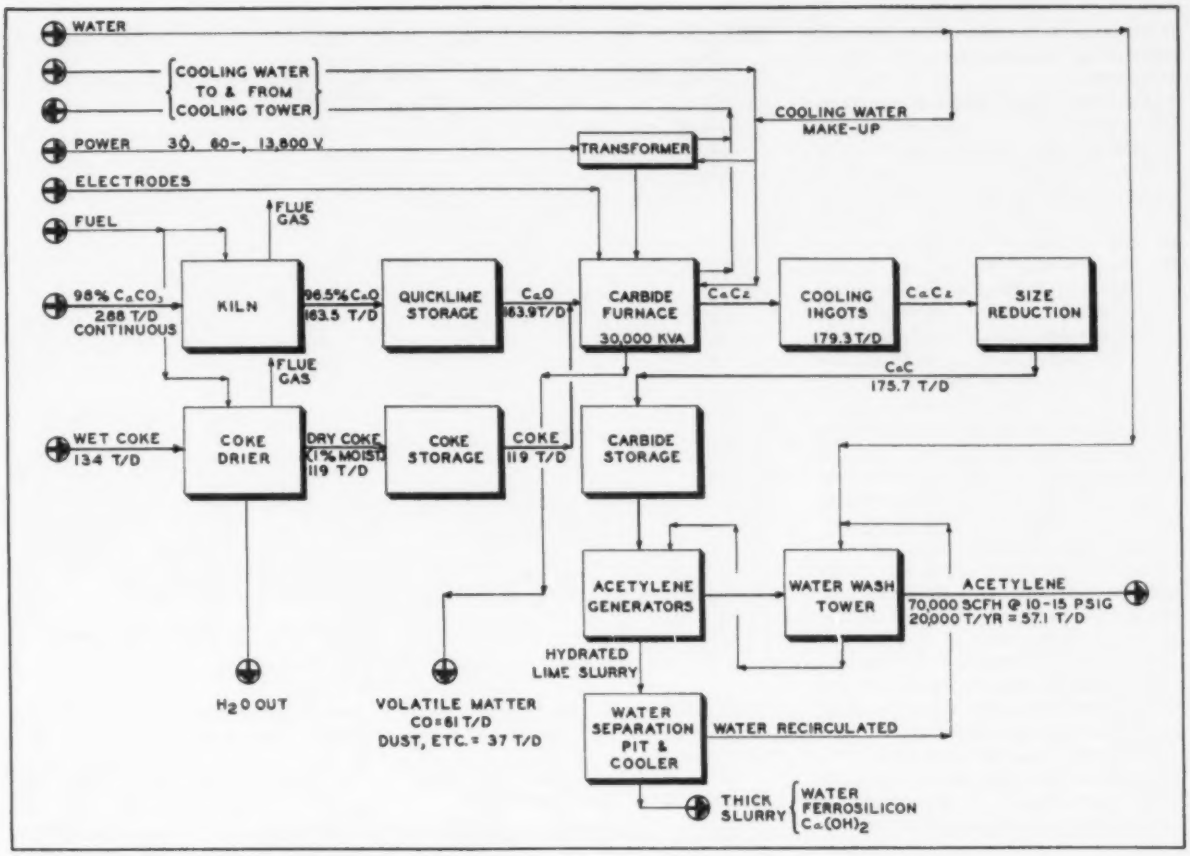


FIG. 3 — Typical carbide and acetylene plant flow diagram, with material balances

By E. L. JONES and F. D. PARKER, Blaw-Knox Co., Tulsa and W. B. STROBEL, Continental Oil Co., Houston

where it is calcined on a heated refractory slab. Coke fines may also be charged with fuel oil to produce lump coke of metallurgical quality. This feature is an additional attraction for the refiner who already has an hydraulic coking unit which produces roughly 50% of the coke as fines, which are not readily usable for things other than fuel. The calcining step here represented enables the value of the coke to be upgraded from $10/ton to $25/ton at present prices.

It is appropriate to point out at this point that the commercially available processes (conventional drum coking, contact coking, fluid coking and decarbonizing) all produce coke which may be calcined to make coke of electrode grade. But they all make coke which is higher in volatile matter than can be tolerated for electrodes, and calcining removes this volatile matter.

Of these several processes, mechanical decoking and decarbonizing provide lump coke which may be calcined directly without the careful agglomeration of fines which is required for processes which deliver small particles of coke. Furthermore, for special situations, the decarbonizing units can be operated at conditions which will produce reasonably controllable yields and properties (volatiles, moisture, etc.) of the coke from a given fuel oil. However, the concepts in this paper are applicable to any of these processes that the refiner might install, or be considering.

Another outlet exists for raw coke from the refinery without special equipment for calcining. Raw coke of suitable size may be charged to an electric furnace with lime for the production of calcium carbide which, thereupon, changes the coke from an almost waste disposal product to a valuable petrochemical intermediate since the acetylene made from hydrolysis of the carbide is a versatile chemical building block. The profits shown for a 40,000 b/d refinery apply on a lesser scale to a smaller refinery or the figures apply to a pool of refineries processing an aggregate of 40,000 b/d of crude. Greater profits are possible if a heavier crude may be substituted, since the total cost line is lowered and a greater coke yield obtained.

You Can Convert Acetylene to Coke via Carbide

The process to make calcium carbide from coke is illustrated in Fig. 3 as a block flow diagram. This plant is for 40,000,000 lb./yr. of acetylene, and is not necessarily tied to a 40,000 b/d refinery, since a small refinery may run a heavy crude to a higher yield of coke, or several refiners may provide coke for a plant of this size.

The physical size of the raw coke should range from ⅛ in. to 1 in. The preferred coking unit to provide a maximum of this type of raw coke is a

drum coker or decarbonizing unit with mechanical removal of the coke from the drums.

The block flow diagram illustrates the complete process and outlines the individual steps required together with data on the material balance for a general situation. Coke from the coking unit is transported to the plant site in railroad cars, stored and screened. On the premise that wet coke is produced, such coke contains approximately 12% moisture and is dried in the dryer using natural gas fuel to 1% moisture. When a decarbonizer is installed essentially dry coke can be produced directly. The dry coke is stored before being mixed with quicklime by automatic weighing devices.

The mixture of coke and quicklime is charged to the carbide furnaces where it is converted into calcium carbide, which contains impurities consisting of quicklime (about 15%), unconverted carbon, and traces of ferrosilicon, nitrogen, sulfur and phosphorous compounds.

Molten calcium carbide at 4500° F. is tapped from the furnace and poured into ingots, which are allowed to cool in the atmosphere to about 600° F. These ingots are then crushed to a size suitable for charging to the acetylene generators. The ferrosilicon is removed from the crushed carbide by a magnetic separator and the carbide is stored in steel bins which are purged with inert gas.

Carbide furnaces require approximately 2900 KWH per ton of carbide, and they also consume preformed electrodes at the rate of 50 lb. per ton carbide. A transformer is required to reduce electric power to approximately 170 volts for the carbide furnaces. Cooling water is required for the transformer, the clamps of the electrodes, and the closed tops of the furnaces. In the acetylene generator water is added to the carbide; raw acetylene is taken from the top of the generators and a hydrated lime slurry is removed from the bottom.

The acetylene is purified by removing trace components of phosphorous, ammonia, arsine, and the lime by a sulfuric acid wash. Traces of acid and hydrogen sulfide are removed by a caustic wash. The purified acetylene is then piped to the customer. Lime hydrate is continuously removed from the bottom of the generators as a dilute slurry with a calcium hydroxide content of approximately 10%.

Either limestone, purchased lime, or recycled lime may be used with the coke in the carbide furnace. The kiln is fired with natural gas and carbon monoxide from the carbide furnaces. This carbon monoxide contains collected fines and volatile matter from the carbide furnaces.

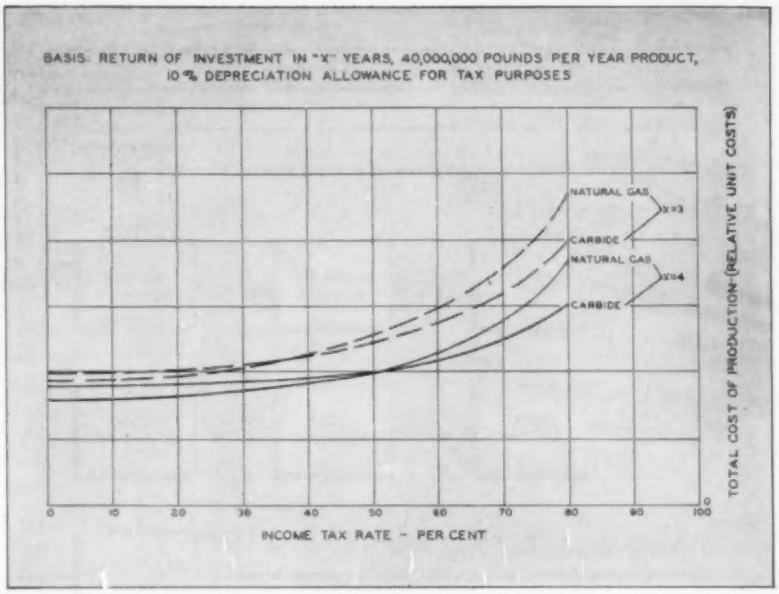


FIG. 4—Effect of tax rate on total cost of producing acetylene from natural gas and from carbide

There Are Advantages in Acetylene from Coke

(1) Acetlylene made from calcium carbide compares favorably in cost with acetylene made from hydrocarbons. The cost of electric power is the major cost in making acetylene from carbide. A lower cost of electric power may be achieved in some localities where power is purchased from a grid by operating the carbide furnace at 75% of capacity during peak periods and at 125% of capacity during the periods when off-peak power can be purchased more cheaply, usually at rates of ½ to 1 mill per KWH less than normal rates.

The cost of making acetylene by thermal cracking of hydrocarbons has been reported in recent literature. Acetylene made from calcium carbide using petroleum coke costs about the same and in addition, possesses certain other very important advantages. The cost figures are relative to any specific installation and naturally vary with the location. However, the figures for acetylene from calcium carbide are based on conventional and commercially proven carbide operations and developments now in progress should reduce the costs still more.

(2) In discussing the production of acetylene from hydrocarbons, natural gas is likely to be the most abundant feedstock and, therefore, the cheapest hydrocarbon available. A plant producing 40,000,000 lb./yr. of acetylene would require 2,000 b/d of propane, if propane were used as feed. Considering the use of refinery products only, it follows that an acetylene plant using propane alone as feedstock would need to be located close to a very large refinery. Also, the supply of coke for feedstock in a Mid Continent refinery location is likely to be several times the size of the supply of propane.

(3) Furthermore, raw coke is not likely to be subject to the price escalation which has occurred and is still occurring to natural gas and other hydrocarbons.

(4) The calcium carbide process delivers pure acetylene with no large quantities of other hydrocarbons which are also produced from other processes using hydrocarbon feeds. For example, in thermal acetylene, off-gas and tars are produced which must be marketed. No such problem exists with acetylene from carbide, so the process economics do not hinge on additional and possibly fickle markets for these by-products.

(5) Processes for producing acetylene from hydrocarbons may not compete with the high purity acetylene available from calcium carbide, which is required for certain chemical syntheses. Acetylene from carbide can be readily produced at a purity of 99.5%; relatively simple refining steps can effect a very high purity.

(6) The carbide furnace produces an off-gas containing carbon monoxide which can be purified to use in certain chemical syntheses, instead of as fuel as was shown on the block flow diagram. This carbon monoxide can be used, for example, with the hydrogen from the refinery's catalytic reforming unit to provide synthesis gas for a variety of products, such as high melting point waxes. (100° C. m.p.)

(7) It is not necessary to convert refinery coke to acetylene, but only to calcium carbide. The calcium carbide may be sold directly to chemical manufacturers or used for fertilizers, etc.

(8) The easiest way to ship acetylene is in the solid form as calcium carbide. This way is also the cheapest except for pipelines, which can only be used for very short distances. The major source of acetylene which is used for chemical manufacture is still carbide shipped by rail. By road, for short hauls, carbide may be moved in closed hoppers on trucks. A central generating plant supplied by trucks or by railroad cars may supply acetylene through a pipeline to several chemical plants.

There is quite a contrast between this mobility for acetylene derived from calcium carbide with the acetylene derived from natural gas. Plants consuming acetylene made from natural gas must be located near the acetylene plant. Therefore, a refiner contemplating markets for carbide from refinery coke should not limit his thinking to the local industries.

(9) Since the acetylene production is based on refinery coke as a raw material, in some cases the refinery may be able to show an additional profit by purchase and processing of a heavier crude.

Other Chemicals You Can Make from Coke

Refinery coke converted in the electric furnace to calcium carbide may be further processed to yield the following products:

Calcium Cyanamid, a fertilizer, is produced when calcium carbide is heated with nitrogen in an electric furnace. The reaction is exothermic and almost self-sustaining once it has started.

Hydrogen Cyanide may be derived from calcium cyanamid by first preparing sodium cyanide in an electric furnace.

Magnesium Metal can be made by heating magnesium oxide at 1100° C. with calcium carbide. Metallic magnesium of high purity (99.99%) was made during World War II in this way. The use of magnesium has been predicted to grow many fold in the next few years.

Acetylene is the basic building block for a large number of very useful chemical products, which may be briefly outlined as follows:

Acrylonitrile for synthetic fibers, plastics, rubbers, and soil conditioners. Hydrogen cyanide is added to acetylene to give acrylonitrile. Both hydrogen cyanide and acetylene may be obtained from calcium carbide which in turn may be made from refinery coke. Acetylene made from carbide is of such high purity that it makes acrylonitrile which does not require the complex purification of acrylonitrile made from hydrocarbon-source acetylene.

Vinyl chloride plastics. By the addition of hydrochloric acid, vinyl chloride may be produced from acetylene. Subsequent polymerization of the vinyl chloride yields a versatile plastic which is the workhorse of thermoplastics. Growth of vinyl chloride production has been phenomenal.

Acrylic monomer is being made directly from carbon monoxide, acetylene and an alcohol in the Rohm and Haas plant in Deer Park, near Houston. Both carbon monoxide and acetylene are available from the carbide route. This plant is an example of the economic advantages of carbide-derived acetylene over ethylene since it costs less to make acrylic monomer from acetylene.

Acetylene black may be made by partial oxidation of acetylene under closely controlled conditions. The black is sold for a premium price for batteries, etc.

Chlorinated solvents such as trichlorethylene may be made from acetylene.

Acetaldehyde, acetic acid and acetic anhydride, widely used chemical intermediates, are available from acetylene.

Reppe chemistry. A very large segment of acetylene chemistry, which is mainly unexplored in a commercial manner, is the chemistry developed by Dr. Reppe in Germany during World War II.

Mr. Parker

Mr. Jones

Mr. Strobel

Meet the Authors

F. D. Parker, manager of western headquarters, Blaw-Knox Co., Tulsa, Okla., is a native of New York City and received B.S. and M.S. degrees in technical engineering from Michigan University.

Early in his career he was with Union Oil Co. of California, first as process engineer and later as research superintendent. During the World War II he was with PAD on avgas work. Following the war, he was chief process engineer for Bechtel Corp., then represented Houdry Process Corp. in the west, and prior to joining Blaw-Knox, he was chief process engineer for Stone & Webster Engrg. Corp.

E. L. Jones, an associate of Mr. Parker with Blaw-Knox at Tulsa, is a native of British Columbia and obtained a B.S. in chemical engineering from McGill University in 1941. Following college he served four years with the Royal Canadian Army in the European Theatre.

Mr. Jones then joined Phillips Petroleum Co., and rose to senior process engineer at Okmulgee, Okla. Since leaving Phillips, he has been doing process and project engineering work, first for Tears Engineers of Dallas, Texas, and now for Blaw-Knox.

W. B. Strobel, technical assistant to the manager of the petrochemical dept., Continental Oil Co., has been associated with that company since his graduation from the University of Colorado in 1948 with an MS in chemical engineering. He also received his B.S. from Colorado, in 1944.

Mr. Strobel's responsibilities are concerned with the utilization of petroleum coke for manufacture of calcium carbide, as well as upgrading other refinery streams for petrochemical purposes.

The manufacture of acrylic monomer from carbon monoxide and acetylene is an example of the commercial use of this Reppe chemistry. Other reactions are of an entirely new nature and yield such diverse products as rocket fuels, blood plasma substitutes, and the like.

* * *

This short dissertation on the value of refinery coke as a petrochemical intermediate and the profits available to the refiner and an adjacent petrochemical plant does not include the other benefits which accrue to the community when public utilities also cooperate. A public utility which provides a low industrial power rate benefits from the extra domestic power used by the families of people required to operate the petrochemical plant or plants, and the related service industries (stores, laundries, etc.). Since acetylene is such a versatile petrochemical, the growth of the community, the public uitility, and the refinery are assured with the use of the additional acetylene by new and different petrochemical plants.

For every unit of additional industrial power supplied by an electric utility to a petrochemical project of this type, it is estimated that a unit of residential and commercial power is also required, at a rate double that of the industrial power. Thus the electric utility supplying the power stands to benefit in two ways, with the revenue from the industrial installation only one-third of the total.

These general community benefits, coupled with the specific profitability to the refiner, underline the present and growing importance of petroleum coke as a valuable petrochemical intermediate.

One additional point may be made regarding the relative costs of manufacturing acetylene under the existing tax laws, and disregarding any proposed changes in them. The tax rate very definitely influences the selling price of the acetylene which must be expected in order for the plant to return the investment before obsolescence of the plant. The relative magnitudes of the investment and the operating costs also influence the price which must be expected. The relationship of these factors is shown in Fig. 4 comparing carbide acetylene with acetylene derived from hydrocarbons by processes recently reported in the literature.(1)

The investment required for a plant to manufacture 40,000,000 lb./yr. of acetylene from calcium carbide made from petroleum coke is about two-thirds of the investment for a plant to make acetylene from natural gas. The carbide plant is based on proven plant construction, whereas, the plant using thermal cracking of natural gas is based on engineering estimates not yet confirmed by actual installations.

The present corporate tax picture is such that a smaller investment with higher operating costs, as is the case of the carbide plant, will pay out faster after taxes than a plant with a larger investment and smaller operating expenses, such as a plant making acetylene from natural gas.

Fig. 4 shows the effect of tax rates upon the relative costs of producing acetylene from natural gas and from carbide made from refinery coke. These costs are relative and not absolute, as the economic picture varies for each location, but the same utility costs were used for this comparison.

For a return of investment in four years, corporations with an income tax rate above 50% would find carbide acetylene to have the lower cost, and the same relation exists for a three year return for corporations with a tax rate greater than 35%.

Conclusion: Refinery coke may be considered as a valuable material which may be used as an intermediate for the manufacture of valuable petrochemicals. These petrochemicals are the types for which markets have been expanding rapidly in recent years. The refiner, alone or in conjunction with chemical companies, can profit from this situation in the manner shown with a proven process for acetylene of high purity from the large quantities of petroleum coke available.

More on Acetylene

Are you interested in more information on acetylene? A limited number of reprints of the article "Acetylene — Coming Petrochemical Building Block?" from the July 1952 issue of PETROLEUM PROCESSING are available—no charge for single copies. Address your request to:

PETROLEUM PROCESSING
Reader's Service Dept.
330 West 42nd St.
New York 36, N. Y.

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NEWS in VIEWS

NEW ANHYDROUS AMMONIA PLANT IS FIRST to use new direct thermal reforming process (Texaco Development Co.'s Partial Oxidation Process), in which commercially pure oxygen and natural gas are converted under pressure to synthesis gas for ammonia production. Plant is Spencer Chemical Co.'s at Vicksburg, Miss., was designed and built by Foster Wheeler Co.

PROCESS EQUIPMENT NEWS

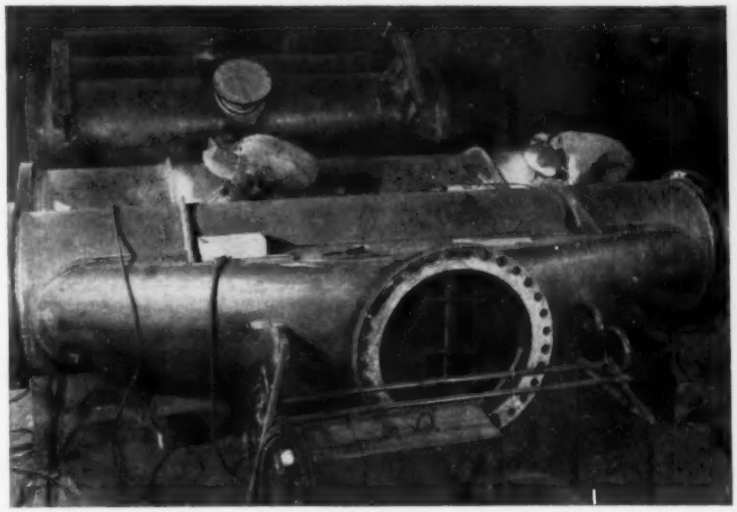
PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY APRIL-MAY 1954

3,360 Red Brass Tubes for This Condenser

Shown on one of Kellogg's boring mills (below) where the gasket face is being machined, this is a channel for one of four sections of a prefractionator condenser currently underway for a southwestern petroleum refinery.

Each bundle of the condenser will contain 840 tubes, ¾ inch in outside diameter by 16 feet in length. The water available for industrial purposes in the particular area where the condenser will be used is especially corrosive. To offset this, specifications call for red brass as the material for the tubes, this alloy having proved by experience to give the most effective protection against corrosion in the locality involved.

Tube sheets for the condenser will be of steel, clad with naval brass. Shell, shell cover, and channel are of steel. Design temperature is 200°F. on the shell side and 150°F. on the tube side.



Big Condenser Will Hold Pressure Drop to 5mm. Maximum

The drip-type condenser shown above in progress in Kellogg's shop has been designed to hold pressure drop on the shell side to the exceptionally low maximum of 5 mm. of mercury. Consisting of two sections, the unit will condense naphtha vapors and steam on the shell side and heat a petroleum distillate on the tube side. Operating pressure on the shell side will be 65 mm., and 150 psi. on the tube side.

Representative of one of the more complex types of exchanger units Kellogg is experienced in building, in addition to all the conventional types, this condenser is designed with an obround nozzle to spread the incoming vapors over the entire length of the tube bundle, thus providing for pure cross-flow heat transfer.

44,000-lb. Reactor for New Chemical Process

Similar in design to units refiners use in transforming certain petroleum gases into polymer gasoline, this big reactor (right) will shortly become an important part of a new chemical plant now building on the East Coast. The plant will be the first in this country to manufacture phenol from cumene, an intermediate material which in turn is obtained from benzene and propylene. This particular unit is the vessel in which the reaction to produce cumene will be carried out.

The tubular reactor is 3½ feet in internal diameter by 35½ feet in length, and is fabricated of high-tensile carbon steel, 1⅝ inches thick. When completed, it will tip the scales at some 44,000 pounds. The unit is designed for an internal pressure of 990 psi, and temperature of 510°F.

For further information, details of methods, etc. contact
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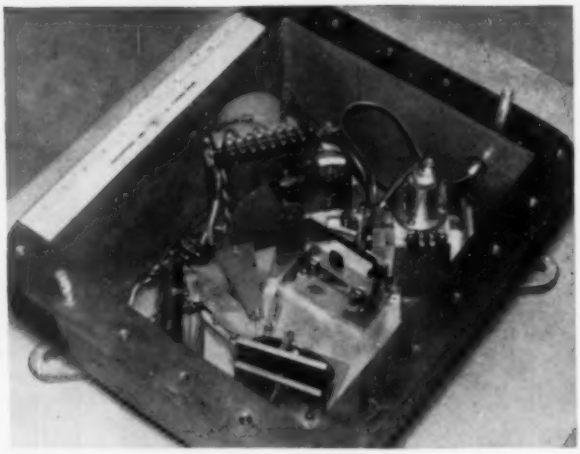


UNUSUALLY COMPACT, the new spectrometer analyzer fits within a standard explosion-proof housing for plant installation

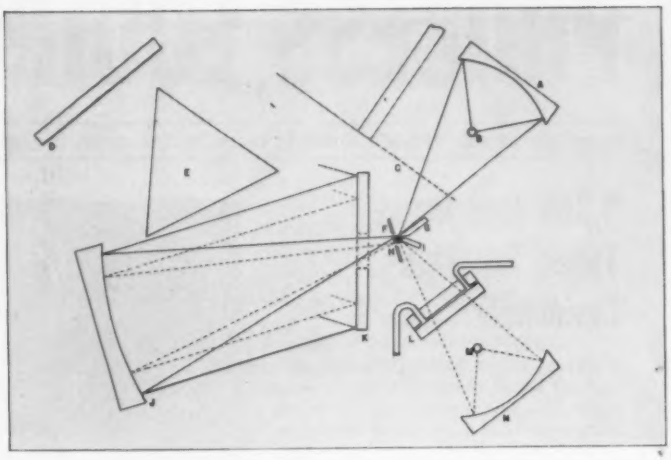


FIG. 1 — PRISM INSTEAD OF FILTER is used in optical arrangement of new plant type process stream analyzer

Infrared Analysis of LIQUIDS

Here's some helpful data on one new and three other analyzers for non-gaseous streams

A NEW spectrometer type infrared analyzer was developed recently for a specific problem at Dow Chemical Co.—to determine minor concentrations of the ortho isomer in a liquid stream of meta and para-ethyl toluene.

It has proved so successful that it is gaining preference even for some applications formerly being handled satisfactorily with the more conventional nondispersing type analyzer, and several instruments of the new design are now in use in the company's plants.

In contrast to the nondispersing type, which depends upon various filter substances to gain selectivity, the new spectrometer analyzer uses a prism to disperse the infrared radiation of the source into a continuous spectrum. Then, in conjunction with an entrance and exit slit pair, the optimum wavelength for a particular analysis can be selected and the sample transmission measured at that wavelength.

Such instruments have been used in the laboratory for analyses for a good many years, but they have not been suitable for routine plant installation because of size and complexity. To meet the requirements of plant use, a spectrometer was designed sufficiently compact to fit into a standard 11 x 13 x 7 in. explosion-proof housing. It is shown in the photograph above. A similar enclosure contains the electronic equipment, the output of which is used to operate any standard recorder or controller to present the analytical results.

A model of this type analyzer was first developed in 1951 and was described in a recent publication.[1] Fig. 1 is a schematic of the optical system.

The source *B* is a small nichrome helix, heated with about 14 watts input. It is focused by mirrors *A* and *G* through the entrance slit *F*. The radiation then passes through a hole in the plane mirror *K*, is collimated by mirror *J*, passed through the prism, and returned by the same path to *J*, which now focuses the dispersed spectrum at the region of the exit slit *H*.

Wavelength selection is made by adjusting a screw which controls the angle of the littrow mirror *D*, so that light of the desired wavelength falls on the exit slit. After leaving the exit slit, the light passes through the continuously flowing sample in cell *L*, and is then condensed on a fast responding radiation thermocouple *M*. For ease of amplification, AC output from the thermocouple is obtained by chopping the light at 6 cps with the rotating shutter *C*.

Fig. 2 is a schematic of the null balance recording system. The AC output of the detector is balanced against a fraction of a 180° out-of-phase voltage generated in the pickup coil *G* by the rotating magnet *F*. The amplifier *I* amplifies any unbalance signal, which is then rectified by the synchronous switch *E*, filtered at *J* and then applied as DC of the proper polarity to the recorder input. The recorder slide wire is then automatically positioned to control the fraction of the generator voltage appearing across R_2 to restore balance. R_3 is a span control.

As an example of the method of analysis with this instrument, the case can be cited for which it was originally designed. It was required to analyze a liquid stream of meta and para-ethyl toluene for minor concentrations of the ortho isomer.

Curve 1, Fig. 3, shows a portion of the infrared spectrum in the region of 13 microns of the meta and para ethyl toluene mixture, recorded with the analyzer using a temporary scanning attachment. Curve 3 shows the same spectrum recorded on a commercial laboratory spectrometer. Curve 2 is a scan of the same spectral region of a meta-para mixture containing 10% ortho ethyl toluene. This shows the strong absorption of ortho in the region at *D*.

For continuous analysis, the wavelength control is adjusted and fixed to transmit light at the energy peak between absorption bands *B* and *E* of the meta-para mixture (where ortho has strong absorption), and the sample transmission is simply recorded at this wavelength. The response is little affected by changes in the meta-para ratio.

An indication of the sensitivity can be seen from a comparison of curves 1 and 2 where we see that approximately 60% of the light is absorbed by the addition of 10% ortho

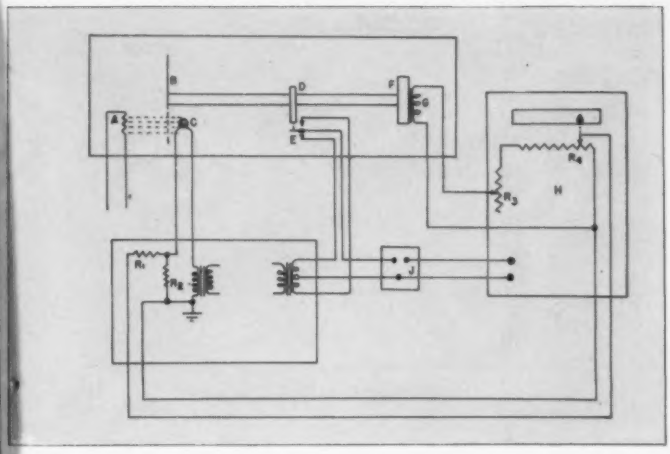


FIG. 2 – Null balance recording system for the new spectrometer analyzer

By L. W. HERSCHER
Dow Chemical Co.

to the mixture. The source output at this wavelength is held to better than 1% by an ordinary constant voltage transformer type regulator.

Standardization is done two or three times per week by introducing a known sample and adjusting R_3 if required. This is actually a span adjustment to correct for possible losses in efficiency of the optical system or source and detector. Zero drift is practically nonexistent.

An analyzer of this type avoids the problems encountered with filter type analyzers in regard to finding a substance for filling the filter and detector cells, and also the continued uncertainty of maintaining the original filling conditions.

Applicability to a new problem can be readily determined by looking at the infrared spectrograms of the substances present in the stream. The less frequent standardization required indicates that these analyzers are less subject to drift than other types, and none of the applications to date have required thermostating of the analyzer housing. Furthermore, this type has the advantage of adaptability to multipoint recording of several components in a stream.

Manufacture of this type of analyzer is now being considered by one instrument company. Another spectrometer analyzer, of somewhat different type and operation has also been announced recently and should soon be made available.

What are some examples of the other useful and typical liquid stream analyzers and how do they work? What are some of the sampling problems to be solved in using such instruments in today's petrochemical or petroleum processing plants for process stream analysis? In addition to the new spectrometer type just discussed, three others will be covered—the total absorption type, the positive, and the negative filter types.

Total Absorption Type

The simplest, and probably the earliest infrared analyzers for liquid streams, were for two component mixtures,

Mr. L. W. Herscher is in charge of infrared instrumentation in the spectroscopy laboratory of Dow Chemical Co., Midland, Mich. He is a graduate of Michigan State College with a B.S. in physics and in electrical engineering, and joined Dow shortly after graduation in 1942.

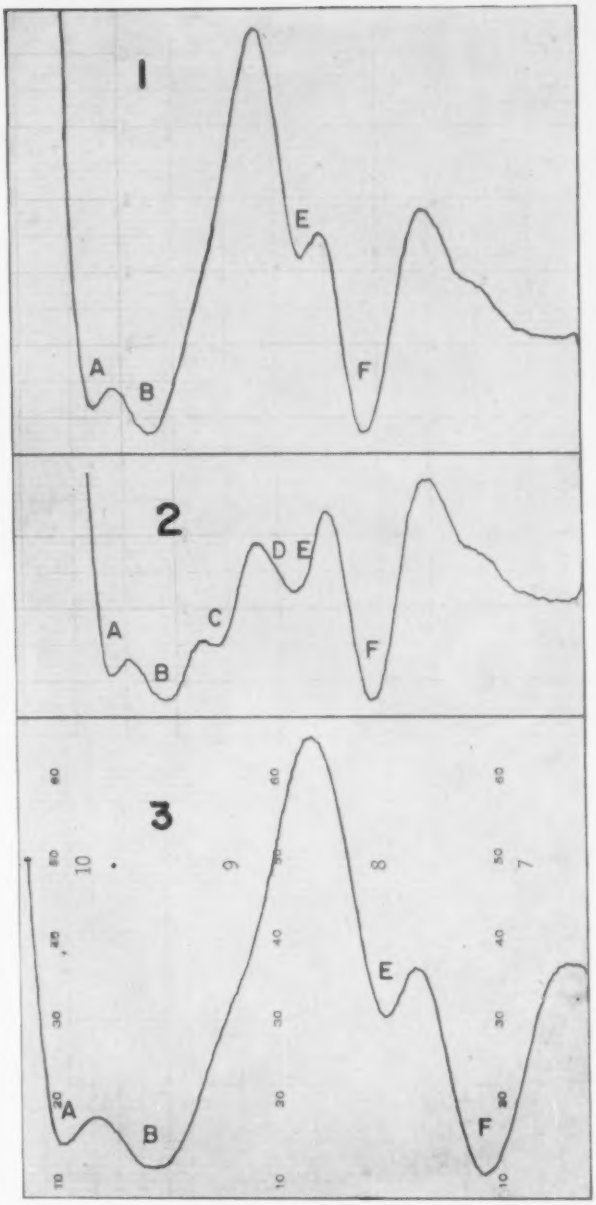
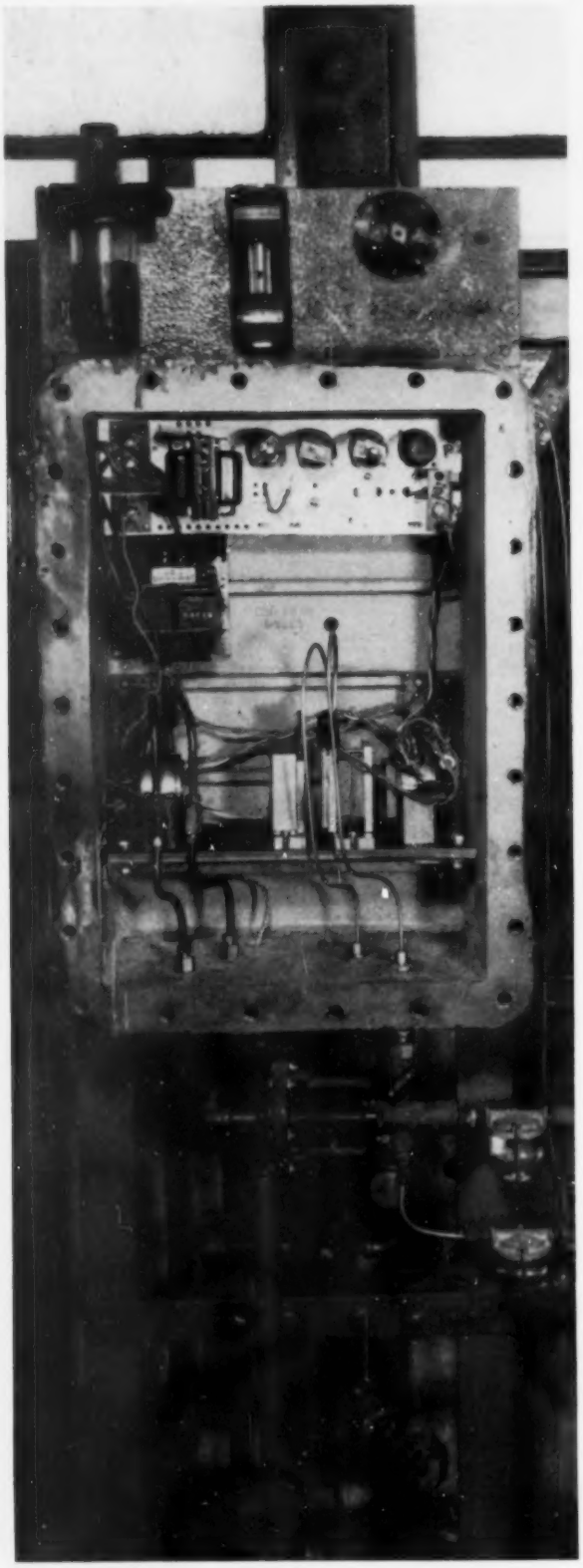


FIG. 3 – Comparison of spectra curve results for the toluene mixtures

usually where one of the components is present as a low percent of impurity.

A good application of this type of analyzer is in the finishing distillation of styrene monomer for separation of etheyl benzene. Ethyl benzene has strong infrared absorption around 3.4 microns. This wavelength is close to the energy peak of radiation from a nichrome coil source at dull red heat.

Under these ideal conditions, it is possible to use the simple optical arrangement of Fig. 4 for a stable sensitive analyzer. Light from the source S is divided into two beams by the split lens L_1-L_2. A continuous sample flows through the cell C in a thin layer, about 0.005 in. thick, where it is traversed by the beam from L_1. The other beam passes beside the sample cell as a reference beam, and it is balanced initially by means of the light trimmer B, to give minimum effect from small changes in the source voltage.



A PLANT INSTALLATION of the total absorption type liquid analyzer

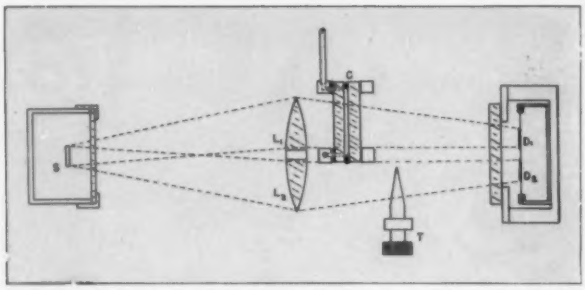


FIG. 4 — Optical plan for a total absorption type infrared liquid analyzer

The detectors D_1 and D_2, are light nickel wire resistance thermometer elements in an AC wheatstone bridge. A decrease in transmission of the light in the sample beam, due to the presence of ethyl benzene, will cool D_1, causing the recorder to move to a new balance point.

The electrical circuit is shown in Fig. 5. A calibration curve, such as Fig. 6, is obtained by running a series of mixtures made up to known concentrations.

It may be worthwhile to note the method of sample cell assembly indicated in Fig. 4, since the cell is an important factor in determining the success of an analyzer. It should be absolutely liquid tight and easily removable for replacement.

The construction shown has proved very satisfactory. The two optical windows are separated by a continuous lead shim with its center cut out. One of the windows is drilled with two holes entering at opposite corners of the opening in the lead shim. Two metal plates, with clamping screws, are used to hold the assembly together. One of the clamping plates is drilled with holes that match those in the window and then connect to the ⅛″ tubing leads which are welded into this plate.

To make a tight cell, the windows are ground flat to about six fringes, and the lead shim is wet with mercury before assembly. Mercury coated lead washers are also used to seal at the holes between the drilled window and metal plate. The undrilled window is backed up with a rubber gasket to give even distribution of the clamping pressure.

This instrument is sensitive to less than 0.1% ethyl benzene. The fact that the analyzer is not specific for ethyl benzene is often an advantage. The presence of almost any possible impurity would be indicated, not necessarily in the correct amount, but at least a warning of any unusual conditions in the process is given.

For instance, the analyzer is sensitive to moisture in the parts per million range. However, the nonspecificity of this type of analyzer does limit its usefulness to a relatively small field.

A plant installation of an analyzer of this type with explosion proof housing open is shown in the photograph. The amplifier seen in the upper part of the housing is required when a galvanometer type recorder is used.

Positive Filter Type

By adding a light chopper and substituting a selective detector, such as a gas filled condenser microphone for the bolometer detectors shown in Fig. 4, a positive filter type infrared analyzer could be made. This type is fundamentally for gas analysis, and its application to liquid streams has not been fully exploited.

The difficulty lies in the chance possibility of finding a suitable gas to fill the detector. This would require a gas with absorption bands at the wavelengths at which the compound to be determined absorbs, and preferably no

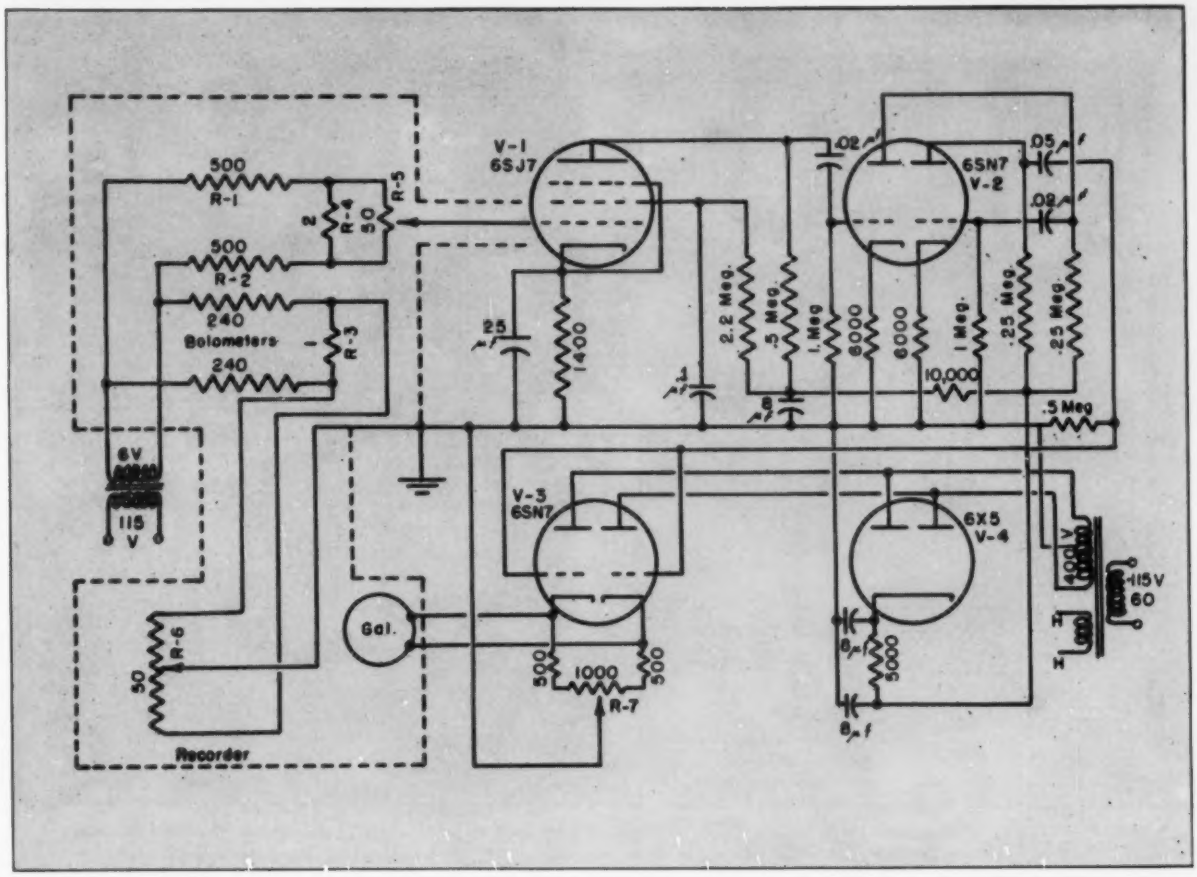


FIG. 5 — Electrical circuitry for amplifier and recording system for the analyzer shown in Fig. 4

bands where they could cause interference from other components of the stream.

In some cases, especially with operation at elevated temperature, the liquid to be measured, may have a high enough vapor pressure itself to be used for sensitizing the detector. A pressure of 15 to 75 mm. is usually sufficient. However, one should first compare the spectrograms of the compound in the liquid and vapor phases, because there may be important differences in the wavelength and intensity of certain bands.

Negative Filter Type

This type of infrared analyzer has proved successful for some of the liquid stream applications. The system is comparable to the positive filter method as to selectivity for a particular component of the stream, but is somewhat more generally applicable to liquids because the detector filling problem is avoided. It is also popular for gas analysis.

Fig. 7 is a schematic of the optical plan of a special design of this type of instrument. This particular optical arrangement was originated at Dow to obtain certain advantages over other available negative filter analyzers. Light from the source 40 is collimated by the mirror 2 and passes through the sample in cell 3. The plate 4 is coated with evenly distributed reflecting spots which aggregate half of the total area of the plate. This divides the light into two portions, a reference beam and a measuring beam, one of which is transmitted through the plate and the other reflected. This beam splitting method divides

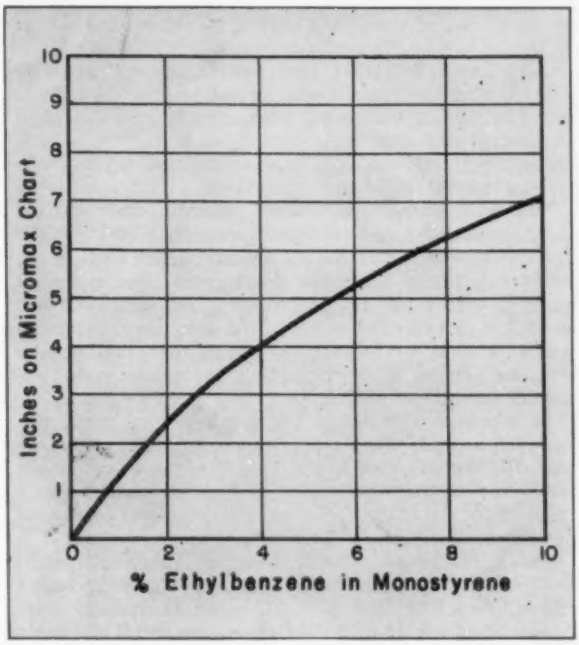


FIG. 6 — Calibration curve for ethylbenzene concentration in monostyrene as determined in the analyzer shown in Fig. 4

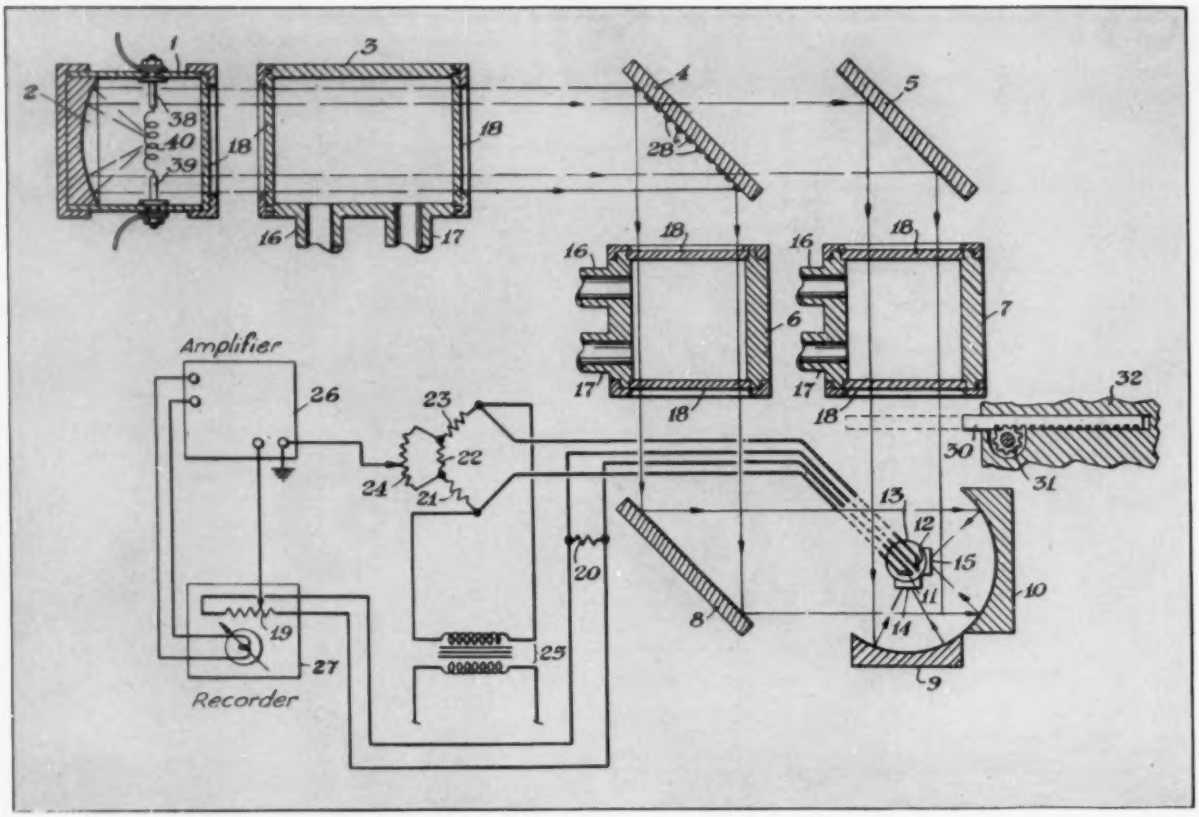


FIG. 7 — Optical arrangement for a special design of negative filter type infrared analyzer developed by Dow Chemical

equally between the two beams, light from all parts of the source and from all ports of the sample cell.

This results in a system which is practically immune to drifts which might arise from dirt or coatings accumulating on the source mirror or windows of the source and sample cell.

After separation, the beams are far enough apart to provide room for solidly constructed leak proof cells in either or both of the beams. Also to facilitate the original sensitizing and later maintenance, each of the cells is entirely separate so that it can be removed without disturbing any of the other components.

The two beams are brought back together by the diagonal mirror 8 and condensing mirrors 9 and 10. The condensing system focuses the beams, one on each of the two 4 mm.-square bolometer detectors mounted at a right angle to each other. By concentrating the light onto this small area, a temperature rise of the detectors is produced which is three or four times greater than that usually obtained, giving a corresponding improvement in immunity to ambient effects.

In common with all of the negative filter types, this analyzer depends for its operation on a filter substance placed in the reference beam. This filter must have strong absorption at the wavelengths at which measurement is required for the analysis. Normally one uses the compound of interest itself for the filter substance.

This is not always possible, however, There is the difficulty of keeping a liquid with high vapor pressure sealed in a cell for a long time. Also, any liquid which might polymerize could not be used. The absorption bands of liquids are usually broad which may present a problem of interference from other components in the stream. For certain applications it is possible to find a plastic film or gas suitable for the filter substance.

Some Sampling Techniques

An improperly designed sampling system for the particular application can easily ruin the performance of an otherwise good analyzer. Fortunately, modifications of the original sampling system can be made if the first operations show they are needed, but this adds to the expense of installation and results in a loss of prestige for the analyzer, besides putting it out of operation when it may be needed most.

Part of the difficulty is that there is no universal sampling system which is best for all applications. The factors of viscosity, sample temperature, cell restriction, filtering, inlet and return line pressures, rate of flow, time lags, drying or scrubbing where necessary and the mixture for standardizing are all factors to be considered in planning the sampling system for a particular application.

It can be readily seen that virtually each one of these factors is interdependent on one or more of the others. For example, any drying, filtering or scrubbing systems in the line add to the sample inventory which in turn determines the rate of flow required for a given time lag.

Perhaps these interrelationships can best be shown by these simple formulas:

$T=I/F$, where T is the sampling time lag, I is the volume of sample inventory, and F is the flow rate.

Also, $F=c\dfrac{(P_1-P_2)}{RV}$ where c is a constant, P_1 and P_2 are the inlet and outlet pressures respectively, R is the

flow resistance of the system (for liquid streams, usually the cell restriction is the largest factor in determining R), and V is a function of the viscosity.

To arrive at a solution with a minimum number of trial substitutions, we can first select the factors over which we have no control or which can be in a limited range only. One of these is the time lag allowance, and this can be determined from consultation with the process engineers. However, the design should be weighted toward more rapid response than absolutely necessary for more satisfactory operation generally.

A second factor where we have little flexibility is in the restriction of the cell to the flow of sample. This is determined, chiefly, by the cell window spacing which in turn is chosen by the spectroscopist to fit the analytical problem. Experience indicates, however, that thicknesses up to twice the optimum spectroscopically, can be used where required by flow rate considerations.

This spacing usually ranges from one to ten thousandths of an inch, and in the case of a viscous liquid, at two thousandths spacing, there is a serious limitation to the amount of fluid that can be put through the cell at a reasonable pressure. Some decrease in the cell restriction can be obtained by grooving one of the cell plates across the inlet and outlet sides so that the fluid pressure is applied across the entire widest dimension of the cell opening.

The pressure applied to standard cells should be limited to 20 to 25 psi. In order to obtain maximum flow rate for the limited inlet pressure, the outlet should be discharged at zero or negative head. If a suitable low pressure discharge point is not available in the process, the small stream from the analyzer (in the order of a few gallons per week) may be discharged into a vented container and returned to the process by pump or manually.

Raising of the sample temperature offers another degree of freedom in the operation of the analyzer. By this means the viscosity can be reduced where necessary to increase flow rate, and also some fusible solids can be liquified and successfully analyzed by infrared. Since standard analyzers are not designed for heating the sample cell alone, it is necessary to operate the entire analyzer at the elevated temperature. Some analyzers are equipped with thermostating equipment which is good up to about 150° F.

Fig. 8 is a diagram of a system designed to meet the somewhat adverse conditions of a sampling problem. The stream has a viscosity of 250 centipoise, roughly equivalent to molasses at room temperature. It contains about 1% of jel solids which have amazing capacity for quickly sealing off almost any type of filter. Also the analyzer is on an automatic control system which requires a fast response time.

In the operation of the system, a ¼-in. side stream is piped a distance of about 15 ft. to a pair of interchangeable filters directly beneath the analyzer. The pump delivers about one gal./min., against the 20 psi head which is controlled by the valve below the rotameter.

The filter design and flow rates give a ratio of velocity across the screen about 15,000 times the rate through the screen, which is fairly effective in keeping the jels swept out. Screen of 200 mesh is used. After one to two days use, the alternate filter is put into operation, and a new screen is installed in the previous filter.

The cell spacing is 0.004 inch, and a groove is cut across the cell window opening at the inlet and outlet to reduce the restriction. To reduce the viscosity of the fluid, the analyzer is insulated, and heated to 130° F. with circulating hot water in a ¼-in. copper tubing coil attached to the analyzer's explosion proof housing.

Under these conditions, the 20 psi pressure produces a

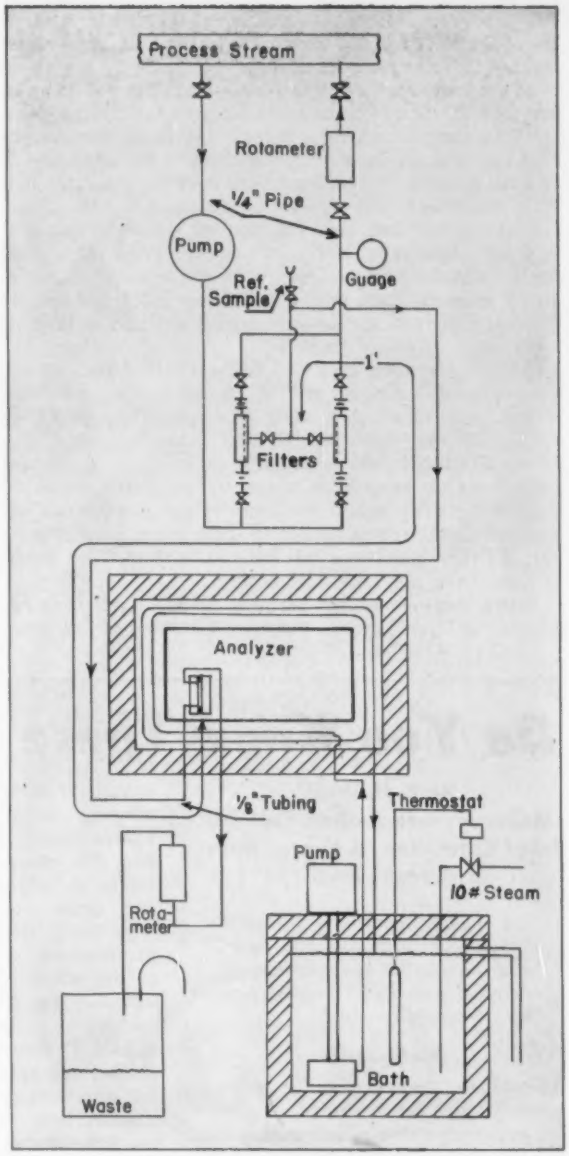


FIG. 8 — Sampling system for an unusually difficult problem

flow rate of around 5 cc/min through the analyzer cell. The volume of the one foot run of ⅛-in. OD tubing is 0.3 cc, with an additional cc inventory on the analyzer side of the screen in the filter.

These values indicate an overall response time of about 30 seconds. The analyzer is checked for zero drift at 24-hr. intervals by injecting, with a hypodermic syringe, a 10-cc reference sample at the fitting provided.

For more common applications of low viscosity and no unusual filtering problems, the bypass stream may be eliminated. For example, if the analyzer can be located within 50 ft. of the process stream, a direct ⅛-in. tubing sample line would have a volume of about 15 cc. With a 0.004 inch cell window spacing and 20 psi differential across the system, a flow rate of about 20 cc/min could be maintained giving a sampling time of under a minute.

A small automotive gasoline line filter has been found to meet the filtering requirements for a dry and relatively clean stream where this order of flow rate can be obtained.

It can be placed in the direct line to the analyzer without seriously affecting the inventory.

In the past seven or eight years—since the beginning of the general use of continuous infrared analyzers on plant streams, there has been a notable lag in the number of liquid stream applications as compared to gas applications. In fact, a check on literature references has indicated that they run about 85% for gas applications.

The reason is not, certainly, that the liquid streams exist in lesser abundance. Nor can it be explained entirely on the basis that liquid streams are more applicable to analysis by other methods, such as refractive index and specific gravity; since those methods are quite limited in their usefulness.

At Dow Chemical Co., 50% of the infrared analyzer applications are for liquid streams. In many cases, however, it has been found that suitable commercial instruments for liquids were not available, and the equipment had to be constructed in the laboratory. Commercial instrument manufacturers have been concentrating development on the more readily solved problems of gas analyzers. Consequently, until recently,[2] and to some extent even at present; delivery quotations on infrared analyzers for liquid streams have not been satisfactory.

When instruments that are now available are made applicable to liquid streams, there are a number of problems, besides the need for converting the sample cells to liquid cells. As a result, each liquid stream application is usually considered a special case.

The use of infrared analyzers for liquid streams can be expected to expand at such a rate as to overtake such analyzers for gas streams in the near future.

This will come about partly through further adaptations of the present non-dispersing instruments. A large part, however, will result from the forthcoming availability of spectrometer analyzers, the only type fully as applicable to liquid as it is to gas streams. These should do much to accelerate the expanding use of infrared analyzers in general. But the greater impetus can be expected in liquid stream applications because of the backlog which has developed in that field.

The preceding article is based on the paper, "Continuous Analysis of Liquid Plant Streams by Infrared," presented by Mr. Herscher at the Texas A&M College Instrument Short Course, January, 1954.

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(1) L. W. Herscher and N. Wright "Small Spectrometer Analyzer for Chemical Process Streams" *Journal of The Optical Society of America*, Vol. 43, No. 11, pp. 980-983, Nov. 1953.
(2) Process Controls Division of Baird Associates, Inc., Cambridge 38, Mass., has announced availability of liquid cell equipment for their negative filter type infrared analyzers.
(3) The Perkin-Elmer Corp. "Two-wavelength Infrared Plant Stream Analyzer" *Instruments*, Vol. 26, No. 4, p. 514, Apr. 1953.

Do You Know These Words?

By B. H. Weil
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Acetonitrile

Acetonitrile, pronounced **"ass**-ee-toe-**nye**-trill," is a petrochemical of growing importance as a solvent and in the manufacture of other materials. Also known as methyl cyanide and ethanenitrile, it has the formula CH_3CN and is a clear, colorless liquid with an aromatic odor. It is lighter than water, freezes at about —42°F, and boils at 180°F.

Acetonitrile is commonly prepared by dehydration (removal of a water molecule) from acetamide (CH_3CONH_2), which in turn is usually manufactured from ethyl acetate ($CH_3COOCH_2CH_3$) by interaction of the latter with ammonia (NH_3). It is used in the synthesis of many organic compounds, such as vitamin B_1 (thiamin chloride) and acetophenone (itself used in perfumery and as a solvent for plastics).

This chemical is a good solvent, and as such finds use in the purification of a variety of substances—removal of coloring materials from petroleum hydrocarbons, deacidifying of fish-liver oils, etc. Acetonitrile also is useful in the separation of mixtures of fatty acids.

In the above-mentioned path of its manufacture, acetonitrile lays claim to the status of a petrochemical by virtue of the preparation of both of its base chemicals (ethyl acetate and ammonia) from petroleum. Both ethyl alcohol and acetic acid (intermediates for ethyl acetate) are being produced commercially from ethylene, from cracked refinery gases. Acetic acid is also being manufactured from acetylene (a pyrolytic product from natural gas) and from a product of the partial oxidation of natural gas. Ammonia is also produced from the latter material.

Acetonitrile is another of the many chemicals which can trace their origin to petroleum. As a link in many chains itself, it faces an interesting and useful future.

Glycerine

Glycerine, pronounced **"glis**-er-in," is a petrochemical of as many important uses as its name has spellings and synonyms (glycerin, glycerol, glycyl alcohol). It has the formula $CH_2OH{\cdot}CHOH{\cdot}CH_2OH$, and is a clear, colorless syrupy liquid with a sweet taste. It is hygroscopic (readily absorbs and retains moisture), heavier than water, freezes at 63°F, and boils at 552°F. Traditionally a by-product of the manufacture of soap, glycerine has since 1948 been produced in increasing quantities from petroleum-derived propylene ($CH_3CH{:}CH_2$) at a rate which by 1956 may exceed that of the original method.

Uses of glycerine read like an industrial chemical dictionary. They include manufacture of alkyd resins and protective coatings, explosives (trinitroglycerine), and emulsifiers for margarine and shortening; employment as a constituent in tobacco (to keep it moist), cellophane, cosmetics, dentrifices, and other drugs and pharmaceuticals; and a variety of other industrial and food applications.

Glycerine is derived from propylene by variations in a series of reactions based on an initial reaction with chlorine to yield allyl chloride. Propylene, in turn, is extracted from refinery cracked gases or is obtained by the deliberate cracking of propane and other petroleum hydrocarbons.

While glycerine is meeting sharp competition from other "polyols" (*poly*hydric alco*hols*) such as pentaerythritol and ethylene glycol, new uses combined with prospects of steady supply at competitive prices bolster expectations for future growth. Petroleum-derived glycerine will dominate the future scene.

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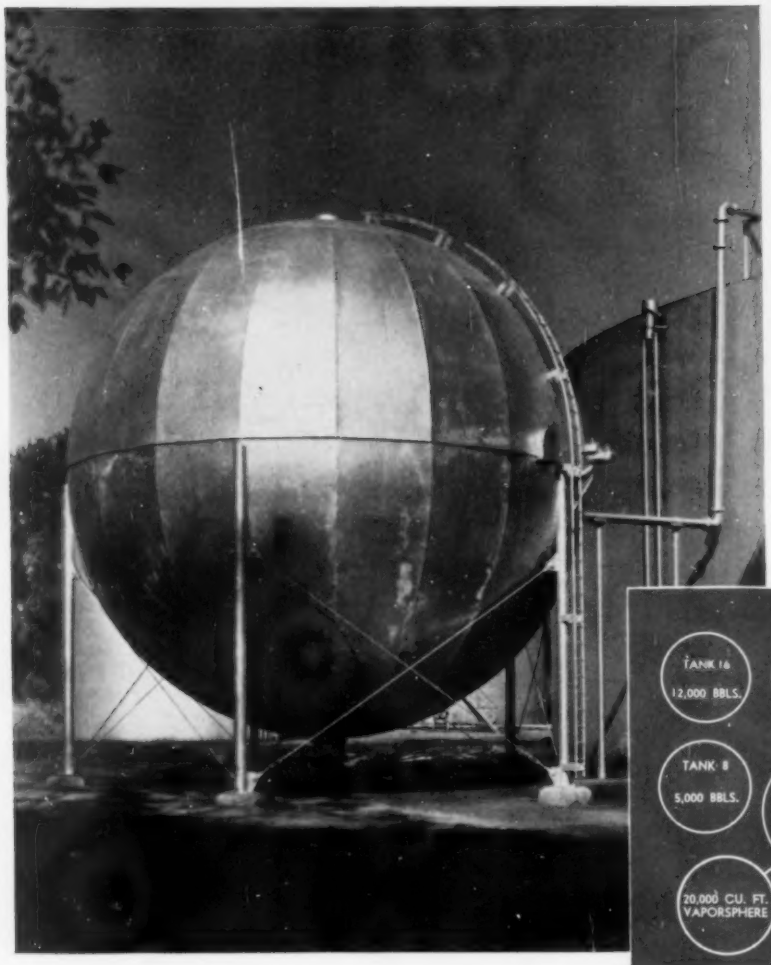

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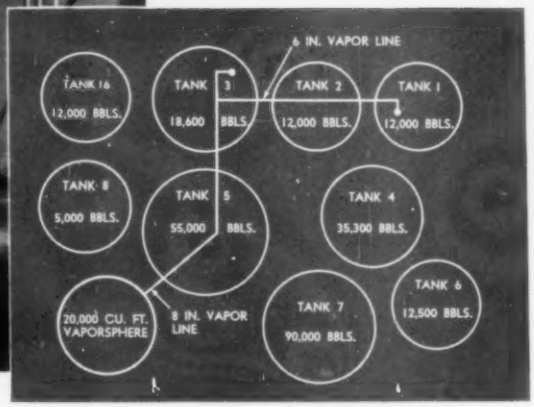

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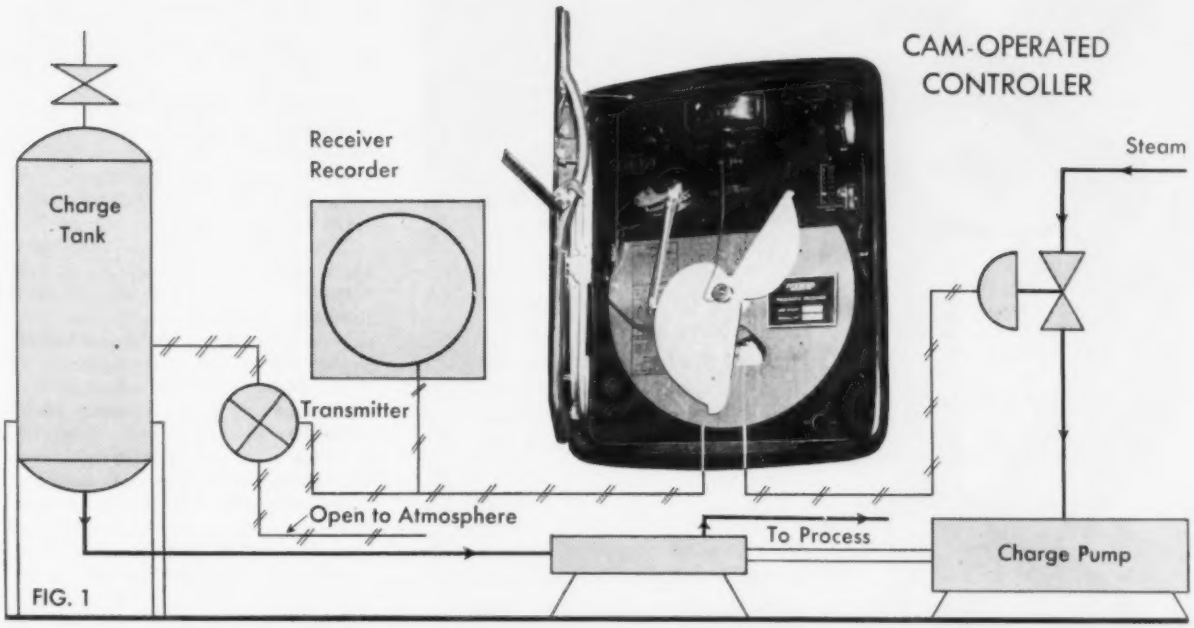


CAM-OPERATED CONTROLLER SOLVES problem of flow control on very viscous materials. Drawing shows general arrangement. Photo shows details of cam

Flow Control of Highly Viscous Oil

By ***ROBERT L. PATTON****

A METHOD has been developed at Gulf Oil Corp.'s Port Arthur, Texas, refinery for satisfactory flow control of a variable-temperature, viscous charge stock in pilot plant operation which involved only minor modifications to the existing instrumentation and did not require purchase of any new equipment.

A new program of pilot plant investigation had required the use of several different charge stocks, one of these being an oil of very high viscosity. Previously, the charge had been adequately flow-controlled with a conventional orifice plate, differential pressure transmitter, recorder-controller, and diaphragm control valve in the steam supply to the reciprocating-type charge pump.

However, this system was inadequate in the control of flow of the high viscosity stock, primarily because of variations in differential pressure across the orifice plate as a result of the viscosity changes with temperature. And there was no convenient means for controlling charge stock temperature.

The differential pressure transmitter was removed from the orifice and reinstalled by connecting to the charge-stock drum to measure the hydrostatic head of liquid. The drum was a vertical, cylindrical vessel, sufficiently large to contain a complete run. The arrangement is shown in Fig. 1.

The circular chart was removed from the recorder-controller and a sheet metal cam substituted, as shown in the photograph. This cam, each lobe of which is used for a different flow rate, was computed so as to move the control index at a predetermined, linear rate of speed when turned by the chart-drive motor. Several different cams were cut to provide the various charging rates required. The recording pen was removed and a pointer installed so that the relative positions of index and variables could be observed.

It was found that the pointer followed the index quite closely after the controller was properly tuned, and good control was obtained. The transmitter air was also "teed" into a nearby recording receiver to obtain a record, and the curves drawn on this chart could be compared with those of the cam.

A true weight-rate-of-flow control was obtained, independent of temperature variations and without the necessity of calculating an orifice coefficient.

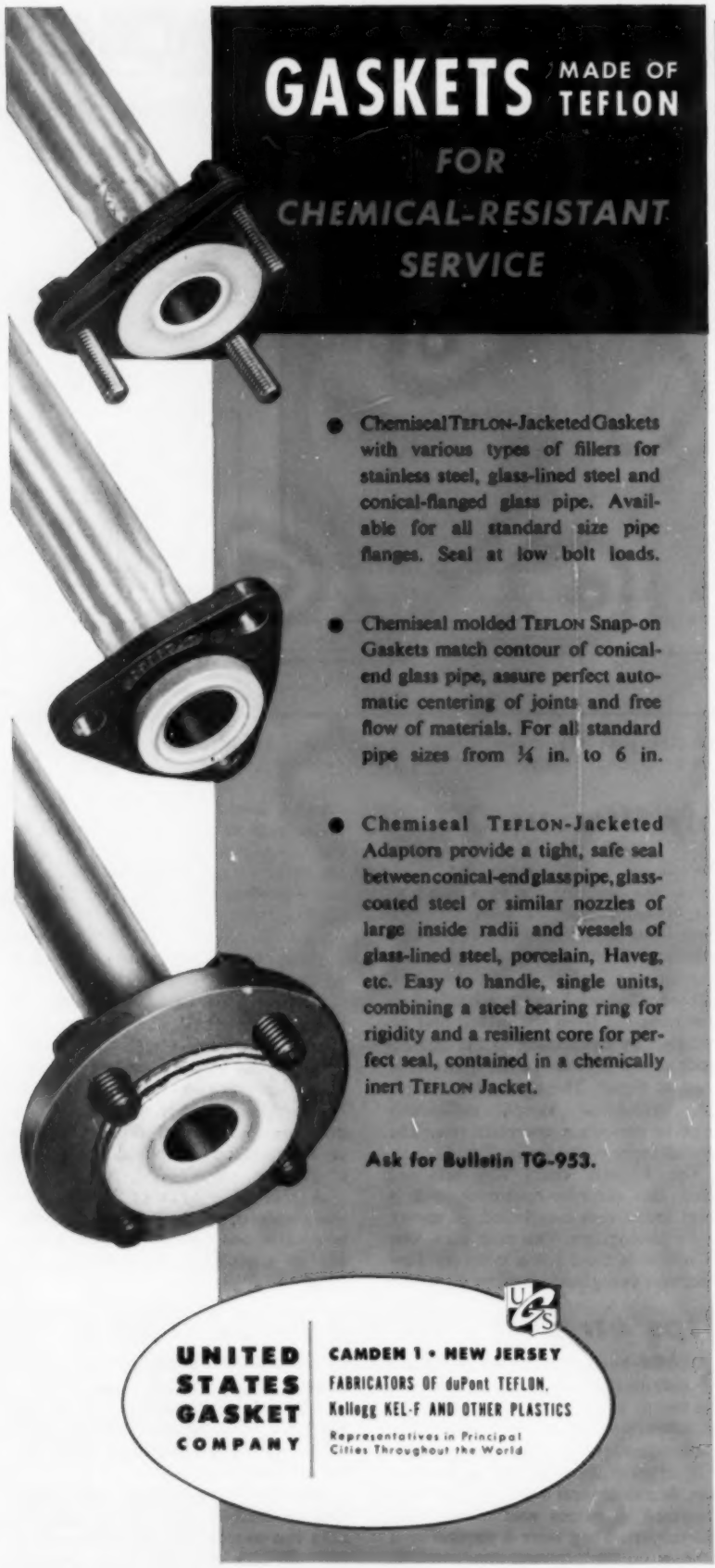
* Mr. Patton is general foreman, instrument dept., Gulf Oil Corp., Port Arthur, Texas. He has been a frequent contributor to the Plant Practices section. The data in this article was presented as a paper, "Small-Flow Controller for High Viscosity Liquids," at the Texas A&M symposium on Instrumentation for the Process Industries in January.

Tips on Ball Bearing Maintenance

SHAFT bearings play an important role in the service life of an electric motor or a pump. Proper fit, installation, and lubrication all are important factors in getting good service.

A series of short articles in this section, begun several months ago, have presented questions and answers on this subject. They were a portion of a seminar on the problem conducted at the Aruba, Netherlands West Indies, refinery of Lago Oil & Transport Co., by Mr. Jack Cannon, Continental Electric Co., and made available to the readers of PETROLEUM PROCESSING by the oil company.

Specific problems have been pretty well covered in the last six articles. Like last month, this issue's questions and answers will deal with general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as well as miscellaneous topics.

If the inner race of a ball bearing is made of one kind of steel and the shaft is made of another kind, won't the differences of expansion cause trouble?

No, the very slight difference of the coefficients of expansion between the two steels will cause no trouble.

If you have two bearings of the same size, will the outside diameters be absolutely identical?

For practical purposes, yes. Naturally, there is a tolerance for this dimension but it is in tenths of thousandths.

What can we use to determine the proper drop-fit in a bearing housing?

The best gauges that you could ever buy are available in your scrap barrel of used bearings. Pick out one bearing of each size. Don't worry about whether the inner races or balls are in poor condition. But do make sure that the surfaces of the outer races look reasonably good.

Send this assortment of bearings to the machine shop so they can be checked for trueness of the O.D. In other words, make sure that the outer races are round. Then, using a ball bearing handbook, make sure that the O.D. is toward the upper tolerance of the dimension; e.g., a 309 bearing has an O.D. that can be as large as 3.9370 in. or as small as 3.9362 in. The bearing you are going to select as a gauge should be no smaller than 3.9367 in. and can be as large as 3.9369 in. The hardness of the outer race is such (Rockwell 62) that you will never wear any material from this gauge.

With a complete set of these ball bearings, which cost you nothing, you now have very accurate plug gauges which should be used to determine the proper drop-fit for bearing housings. Never use a new ball bearing.

Is the material used for the races different from that used for the balls?

As far as we know the material is the same. But the balls are heat-treated to Rockwell 64 and thus slightly harder than the races, which are treated to Rockwell 62.

If a single-row, deep groove bearing is better than the same size bearing with filler slots, why do the manufacturers keep on making the latter?

The real answer is not known. But because the large industrial users continue to order filler-slot bearings as replacements for original equipment, the bearing manufacturers will continue to make them.

Why is there no locknut on some pumps to hold the bearing on the shaft?

 (To obtain more data on advertised products see page 776)

If the inner race is at least a metal-to-metal fit on the shaft and there is no end-thrust, then a locknut is not necessary, because the purpose of the locknut is to prevent movement of the ball bearing away from the shoulder of the shaft through some thrust.

What effect does the number of balls have on the load capacity of a bearing?

At present, this effect is not known for a certainty. About four years ago, bearings with filler slots and a maximum number of balls (usually 12) were given more radial capacity than the same size ball bearings with only eight balls—known as the "single row deep groove." Today, however, the handbooks rate this latter bearing, with a lesser number of balls, at a higher capacity than the maximum type bearing. You can see why our answer is indefinite.

If you are not sure that angular contact duplex bearings are matched, how can you check them?

Obtain a pair of "C" clamps that will enable you to grip the inner races of a pair of the duplex bearings without touching the outer races. The "C" clamps must be cleaned before you attempt to use them. After providing a clean bench, wipe the surface grease from the new bearings with an absolutely clean rag. Place the bearings together D.B. (which means the heavy shoulders of each race are against each other). Line up the bearings on a flat surface and use a "C" clamp on each side to hold the inner races against each other. Do not tighten the clamp more than finger-tight.

Now you can pick up the two bearings as one. Turn the outer races while holding the inner races, and see if the bearings turn freely and smoothly. If they are free and smooth, the bearings are not pre-loaded. Next, turn the outer race of one bearing while holding the outer race of the other and see if there appears to be as much contact between the outer races as between the inner races. If both tests come out O.K., then you have a pair of matched duplex bearings which can be used in either the D.B. or the D.T. positions.

Can you tell if duplex bearings have been matched by the manufacturer?

MRC bearings that have been factory matched have the letter "D" stamped into the face of the outer race after the number of the bearing; e.g., 7314D. There is also the letter "D" stamped into the face of the inner race. SKF marks factory matched duplex bearings with letters "BG," put on with an electric pencil after the number of the bearing; e.g., 7314BG. There are different codes for other manufacturers.

Answer to an H_2S Corrosion Problem

HERE'S a suggested solution to a problem involving sour gas attack on compressor bearings. It is based on information developed during a conference in Montreal for representatives of several Canadian oil companies and of International Nickel Co. of Canada. It was prepared for PETROLEUM PROCESSING by John F. Mason, Jr., corrosion engrg. section, development and research dept., International Nickel Co., New York. A major portion of Mr. Mason's work appeared in an article in September, 1953, pp. 1332-1335.

Problem: Bearing liners and babbitt materials made of copper-tin-lead bronze and tin-antimony-copper babbitt have proved to be unsatisfactory in centrifugal compressors handling hydrocarbon gas containing H_2S at temperatures up to about 200° F. What other materials might be better for this service from a corrosion resistance standpoint?

Discussion: We have not had very much experience with bearing materials in centrifugal gas compressors. But we are not surprised that the alloys used have suffered corrosion effects by the sour gas containing H_2S at 200° F.

To provide better insurance against corrosion from the conditions as described, the use of the following materials—or combinations of them—to prevent seizing or galling is indicated: 18-8 stainless, 12 and 17% chromium steel, Monel, Inconel, and Ni-Resist.

These alloys are highly resistant to corrosion by sour gas, and a combination of Monel and one of the stainless steels mentioned would provide freedom from galling with the expectancy of long and satisfactory service life. Ni-Resist has found wide application for bearing liners and this material could be safely used in conjunction with Monel for a satisfactory performance.

It is understood that a number of refineries have overcome this problem by purchasing a particular type of gas compressor with bearings on the outside of the case. Such a set-up would of course eliminate the corrosion problem by keeping the sour gas from contacting the bearing surfaces.

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3

hydrofining units

Foster Wheeler will design and construct for the Esso Standard Oil Company, at the Baltimore refinery, 3 Hydrofining units (catalyst + hydrogen) for the desulfurization and general quality improvement of napthas and heating oils . . . and a fixed-bed Hydroforming unit (catalyst + hydrogen) for Octane upgrading of heavy naptha.

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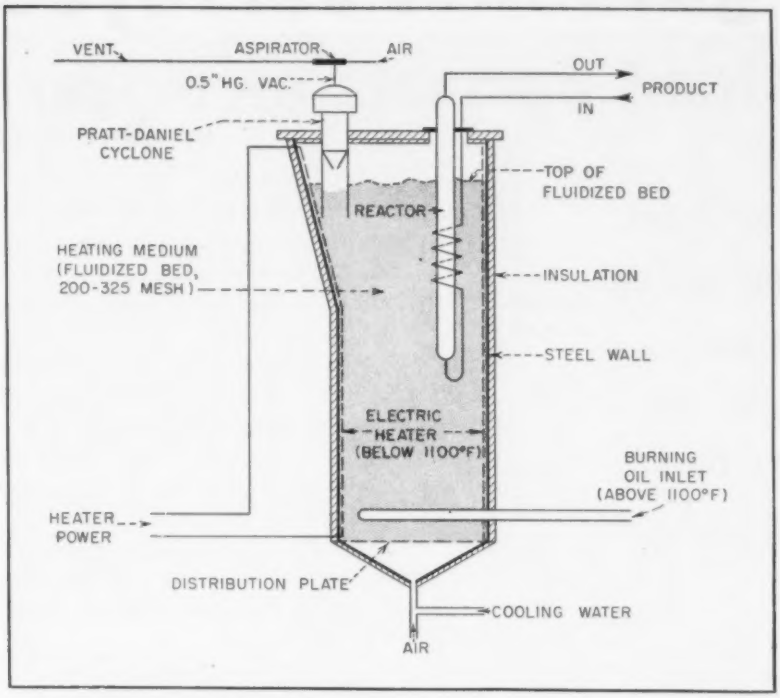

SPENT CATALYST IS HEATING MEDIUM in this laboratory unit using the fluidized solids technique

Lab Heater Uses Fluid Technique

ONE of the big headaches around the laboratory and pilot plant is the heating medium which is called for in many operations.

Many substances and arrangements have been attempted for these heating baths in the past, including molten metals, organic and inorganic compounds, and heat transfer through solid blocks of metal in turn heated by various means. Various methods of control have been used; some successful, some otherwise.

The fluidized bed technique, used so successfully in catalytic cracking and other process operations, appeared to have much to offer as a convenient laboratory means for heating reactors. Use of granular solids suspended in a gas stream has shown itself to be safe and simple as a method of supplying heat, since it is isothermal in operation, has a high heat capacity, and develops a uniform surface temperature.

The temperature range may be from room temperature to 1600° F. and, with proper selection of materials, higher temperatures are possible. The maximum heat transfer rate for a given solid will vary according to particle size, but experience has shown that a rate of 100 Btu./hr. can be had without trouble.

A device using this technique is very simply constructed, as indicated in the sketch. A piece of steel pipe (other materials may be substituted if desired) of a length which will depend upon the size of reactors to be accommodated is externally insulated with asbestos, magnesia block or other material. At the bottom of the pipe is placed a perforated steel plate containing 1/16-in. holes with a spacing of at least one hole for every sq. in. of area. A circular pattern is satisfactory so long as relatively few holes are used in the center of the plate.

An inlet cone is welded on to the bottom of the pipe carrying an inlet nipple which preferably should have a T-connection so that air can be let in through the straight section of the tee and cooling water as necessary be let in through the branch.

Other connections to the pipe include a heating oil inlet just above the distribution plate in the bottom in the event it is desired to heat the reactor by injecting oil or some other combustible material. On the inside of the pipe, electric heater wires may be wrapped with only sufficient insulation to prevent short circuiting.

It is preferable to weld a short teapot-spout onto one side of the reactor at the top to provide more working room for inserting and withdrawing a reactor. An insulated cover (or a number of covers to accommodate various sizes of reactors) should be provided, with a hole at one side to accommodate the reactor and one at the other to carry the vent connections.

The vent consists of a Pratt-Daniel cyclone or other suitable arrangement to knock back any heating medium entrained in the fluidizing stream. It has been found desirable to connect the vent from the cyclone to an air aspirator and carry a pressure of ½ in. Hg. on the vent line to the cyclone.

The heating medium may be discarded cracking catalyst, sand or any other material which may be available. In size it should range between 40 and 200 microns, or from 200 to 325 mesh.

Electric heating will ordinarily be sufficient for temperatures from ambient to approximately 1100° F. For temperatures above this range burning oil is usually the heating medium of choice, the reactor first being brought to ignition temperature for the oil by means of electric heaters. Reactors may be of any desired shape. They should have a support flange sufficiently large to cover and seal the hole where the reactor is inserted.

Ordinarily the weight of the reactor will be sufficiently great to hold the reactor firmly in position without the necessity of holding it down. However, when a long reactor is used it is not always possible to get stable operation because the catalyst or heating medium starts bumping the reactor around. In such cases it may be necessary to use a bolt or two through the reactor flange into the cover to hold it down tightly.

As an added convenience, an overhead hoist may be used to pick up the reactor for insertion and removal. Such a reactor can be rather quickly brought to an operating temperature and, by disconnecting the heat and using air alone, or with water, can be rather quickly brought to a lower temperature.

The preceding information has been condensed from paper presented at a New Orleans meeting of the American Chemical Society, entitled: "High Temperature Fluid Solids Heating Bath for Laboratory of Pilot Plant Use," by C. E. Adams, M. O. Gernand and C. N. Kimberlin, Jr., Esso Standard Oil Co., Baton Rouge, La.

91% of gasolines surveyed contain significant amounts of copper!

While this is a staggering figure, Du Pont's latest gasoline quality survey shows it to be true . . . indicating that copper contamination resulting in gum formation poses an important problem to most refiners.

A recent Du Pont gasoline quality survey included an analysis of copper content. When the nationwide results were tallied, they revealed some startling information about this gum promoting element.

Out of 241 service station samples obtained in forty-four U.S. and five Canadian cities, *91% contained copper in significant amounts.* The copper content found in these samples ranged from .01 to .90 mg/liter. These figures are highly significant because in many cases, even concentrations of copper below .01 mg/liter have been found to be detrimental to gasoline stability.

Gum content

Because the analytical method used in this survey does not distinguish between free and deactivated copper, the analysis was carried a step further to determine the gum content of each sample. As was to be expected, the gasolines known to contain metal deactivator were low in gum content in spite of high copper concentrations. Conversely, others, without metal deactivator, were found to be high in gum content.

The results of this survey indicate clearly that, in spite of great pains taken to prevent copper contamination during refinery operation, copper is getting into the majority of gasolines sold—probably from contact with valves, pumps and other sources associated with distribution. Based on the gum findings, there are also indications that refiners who are already using a metal deactivator may not be using enough to guarantee maximum stability all along the line.

How can you be sure?..

Du Pont Metal Deactivator was developed especially to prevent copper from accelerating harmful gum formation in gasolines. And in most cases it gives effective protection for less than ¼ cent per barrel.

To help you determine the amount of Metal Deactivator required to assure that your gasoline reaches the customer in refinery fresh condition, one of our conveniently-located regional laboratories will be glad to evaluate its effectiveness in your own stocks. Address your request for this service to the nearest regional office listed below.

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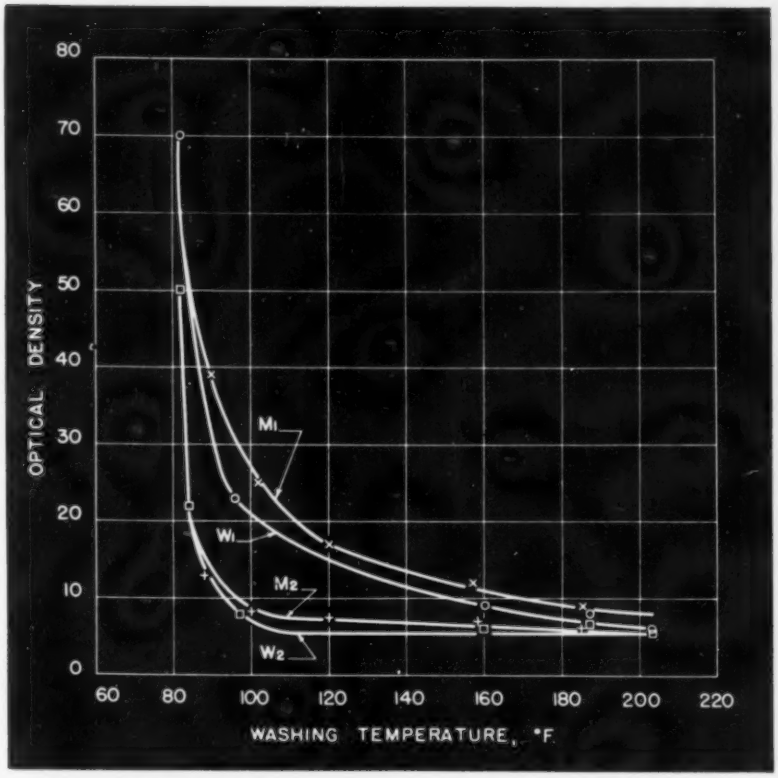
By Peter J. Gaylor, Patent Attorney, Newark, N. J.



EFFECT OF WATER WASHING temperature on aged color of copper-treated heater oil (U. S. 2,653,124)

Hot Water Wash Improves Color Stability of Copper-Sweetened Oils

IN U. S. Patent 2,653,124, Standard Oil Co. (Indiana) reports the discovery that the color stability of an oil that has been cupric chloride sweetened is greatly improved by water washing the sweet oil at elevated temperature. A satisfactory color stability is obtained when the cupric chloride treated oil is water washed at temperatures preferably above 180° F. When metal deactivator is added to the oil sweetened this way, the water washing should not be carried out above preferably 110° F.

The chart above shows the effect of temperature in hot water washing of cupric chloride sweetened oil from two types of crude. All four curves are for sweetened heater oil; i.e., a distillate boiling between 350°-650° F. obtained in one case from a very high sulfur West Texas crude (the W curves), and a low sulfur Mid-Continent crude (the M curves). The subscript "1" represents the sweet oils without metal deactivator addition, and the subscript "2" represents the sweet oils with deactivator (N,N′ disalicylidine-1,2-diaminopropane).

The chart shows that an aged color of +10 Saybolt (about 9 optical density) can be obtained by water washing the cupric sweetened oil at about 100° F. and adding about 0.001% metal deactivator. At a washing temperature of about 110° F., the beneficial effect apparently approaches a maximum, and the aged color of the hot water washed oil plus metal deactivator is substantially constant with increasing washing temperature.

The beneficial effect of hot water washing on the oil without deactivator is great even though not as remarkable as the hot water washed oil plus deactivator. A washing temperature of about 155° F. is needed to produce a borderline finished oil. However, at a washing temperature of about 180° F., the hot water washed only oil is very nearly equal in color stability to the water washed oil plus deactivator. For the oils used, about 220° F. appears to be the highest temperature of water that can be obtained without use of superatmospheric pressures.

Commercial experience indicates that a cupric chloride sweetened heater oil will have an acceptable color stability if the accelerated aged color is +10 Saybolt color or better (about 9 optical density).

Preventing Sourness When Re-Running Naphthas

IN the production of special naphtha fractions having a boiling range of about 225°-421° F., the accepted sweetening procedure to remove mercaptans is by an oxidation process which can be adequate to give a doctor sweet product. However, when the doctor sweet naphtha is re-run in a fractionating column, very often a sourness develops, presumably due to decomposition of sulfur compounds at the high temperature of distillation.

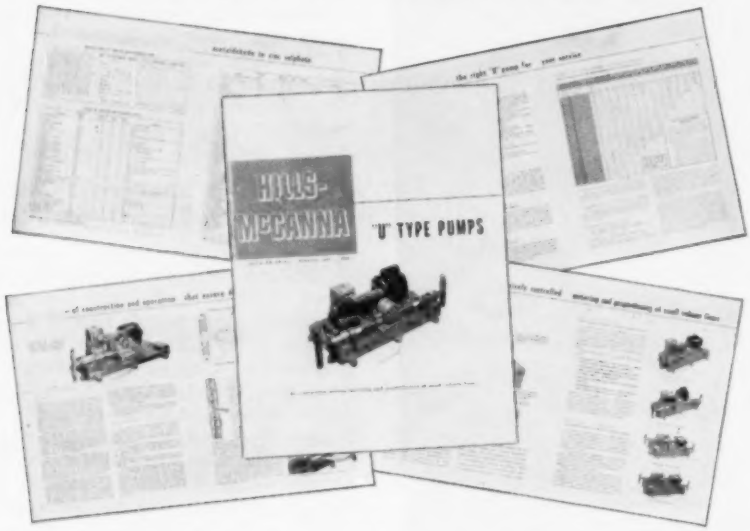
In U. S. Patent 2,670,319, the Pure Oil Co. claims that such development of sourness can be prevented by carrying on the fractionation in presence of a small amount of organic peroxide, such as di-tert. butyl peroxide, benzoyl peroxide, methyl tetralin peroxide, etc. Amounts as low as 0.001% of the weight of the distillate treated in some instances are effective. Usually amounts less than 0.5% are needed.

Mercaptan Removal from Heavy Fuel Oils

THE removal of mercaptans from heavy naptha, kerosene, diesel oil, heater or furnace oil, etc., with little or no degradation of the color of the oil is claimed to be effected by Standard Oil Co. (Indiana) by contacting the sour distillate with 25-100% by volume of non-alkaline methanol solvent which contains not more than about 10 vol.-% of water, separating the solvent and dissolved color-forming bodies from the extracted oil, water washing the extracted oil to removed dissolved methanol, treating the washed oil with 1-15 vol.-% of a concentrated aqueous caustic solution, introducing a free-oxygen containing gas into the oil and caustic while maintaining 80°-125° F. (the caustic containing 0.004-0.3% of copper compound), and separating the spent caustic from the treated oil.

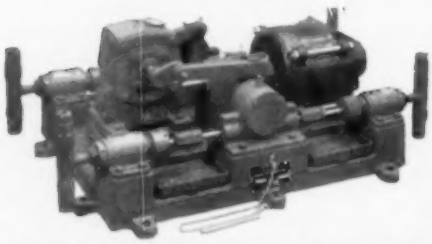
The copper compound (preferably sulfate) is the oxidation catalyst. Contact time with the caustic is 5-60

Here's a handy guide to the selection of metering and proportioning pumps



In this new catalog and pump selection manual for Hills-McCanna "U" Type Metering and Proportioning Pumps is all the information, including prices, for the selection of exactly the right pump for handling over 300 substances. Clearly and concisely, this helpful booklet gives all the necessary information and specific recommendations to cover the vast majority of needs that can be filled with a Hills-McCanna "U" Type Pump.

If your operations involve the metering or proportioning of small volume flows, you will find this catalog a useful addition to your files. We will be pleased to send you a copy on request. HILLS-McCANNA COMPANY, 2448 W. Nelson St., Chicago 18, Illinois.



Hills-McCanna "U" Type Pumps are reciprocating, variable stroke, mechanical drive units with maximum capacities ranging from 0.10 to 24 gph. per feed. One, two, three and four feed assemblies are available. Operating pressures up to 5,000 psi. A four feed unit is shown at the left.

HILLS-McCANNA

metering and proportioning pumps

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minutes. The caustic preferably is 50-60% aqueous KOH. The minute amount of residual copper in the finished oil (not over 1 ppm.) is counteracted by a metal deactivator, such as 0.001-0.01% N,N′ di-salicylidine-1,2-diaminopropane.

Patents Issued in March

The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for March 2, 9, 16, and 23, 1954, Vol. 680, Nos. 1-4.

PROCESSES

Refining

2,670,810 (Union Oil Co. of Calif.) Acetylene recovery with pyrrolidine or piperidine compound solvents.
2,671,008 (Koppers Co., Inc.) Separation of acid gases from coal carbonization gases by alkaline absorbent.
2,671,046-7 (Standard Oil Co.-Ind.) Refining of hydrocarbon oils with SO_2 and halide promoter (BF_3).
2,671,048 (Universal Oil Products Co.) Treatment of hydrocarbon distillates with air, phenylene diamine and oil soluble base.
2,671,049 (Standard Oil Co.-Ind.) Odor improvement of petroleum oils by removing mercaptans and treating with mercuric salt.
2,671,324 (M. W. Kellogg Co.) Method of gas separation, including impurity removing steps.
2,671,722-3 (Standard Oil Development Co.) Synthesis gas desulfurization, using char particles.
2,671,762 (Sinclair Refining Co.) Process for resolving emulsions with sulfonated demulsifier.
2,672,034 (Standard Oil Development Co.) Dehydration of liquefied petroleum gas by rectification.
2,672,433 (Anglo-Iranian Oil Co., Ltd.) Catalytic desulfurization of petroleum hydrocarbons in presence of hydrogen.
2,672,457 (Phillips Petroleum Co.) Process for the decomposition of urea and thiourea adducts.
2,673,176 (Phillips Petroleum Co.) Method of separating components of an organic mixture, using silica gel.
2,673,188 (Standard Oil Development Co.) Method of making alumina containing adsorbent materials.

Catalysts

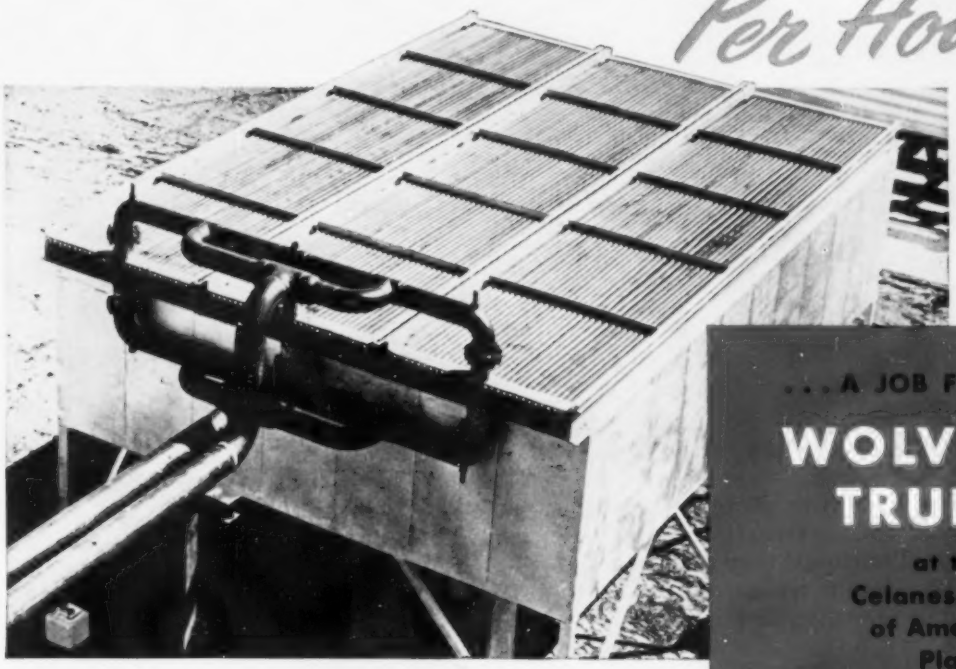
2,671,056 (Du Pont Co.) Process of preparing a silica sol.
2,671,058 (Filtrol Corp.) Process for preparation of acid activated clay.
2,671,763 (Allied Chemical & Dye Corp.) Regeneration of nickel-sulfide-alumina type catalysts.
2,671,764 (Jefferson Chemical Co., Inc.) Promoted supported silver surface catalyst and process of preparing same.
2,671,766 (Jefferson Chemical Co., Inc.) Process of producing silver surface catalysts and such catalysts.
2,672,452-3 (Universal Oil Products Co.) Manufacture of inorganic oxide spherical particles in oil suspensoid.
2,673,139 (Allied Chemical & Dye Corp.) Manufacture of aluminum fluoride catalyst.
2,673,187 (Standard Oil Co.-Ohio) Beryllia regeneration of iron-poisoned cracking catalysts.
2,673,189 (Imperial Chemical Industries, Ltd.) Preparation of copper-nickel-aluminum catalysts.

Conversions

2,671,015 (Imperial Chemical Industries, Ltd.) Gasification of carbonaceous materials in fluidized system.
2,671,050 (Standard Oil Co.-Ind.) Stainless steel alloy and apparatus for converting hydrocarbons.
2,671,057 (Sun Oil Co.) Apparatus and method for contacting solids with gases (catalyst regeneration).
2,671,117 (The Texas Co.) Hydroxyl aromatic hydrocarbonolefin polymer alkylation with $AlCl_3$. HSO_4 catalyst.

(To obtain more data on advertised products see page 776)

"Get Rid of 229,400,000 BTUs Per Hour!"



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at the Celanese Corp. of America's Plant

"Get rid of 229,400,000 BTUs per hour!"

That's the size of the job tackled by 26 Alco "Aircoolers" in the Celanese Corporation of America's plant at Pampa, Texas. Vital to the success of the installation is the role played by Wolverine Trufin Type L/C—*the bi-metal integral-finned tube.*

In this application, the integral-finned aluminum tubing resists corrosion of sour gas contained in the atmosphere. At the same time, a stainless steel liner retards the corrosive action of acetic acid, methyl and ethyl acetate. The two metals are in tight mechanical bond, which provides a maximum rate of heat transfer over a long period.

The ability of Trufin to stand up under varying temperatures, vibrations and pressures is just one of the reasons for its selection in this installation.

About 220,000 lineal feet of stainless steel and 110,000 pounds of aluminum tubing comprise this Trufin installation. The 26 cooler units possess a total of 57 tube bundles—any of which can be removed by simply sliding them out of their stainless steel channel frames.

Trufin can help you, too: Yes, Wolverine Trufin—of bi-metal, copper, copper-base alloys, aluminum, electric-welded or stainless steel—can do a job for you, too! You'll find all the information you need in Wolverine's new condenser tube booklet. Write for your copy—today! WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., 1441 Central Avenue, Detroit 9, Michigan.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

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Unretouched View of an Irrigated Tower Section Photographed th... Tower.

Examine the photograph above. Note that no two or three pieces of Intalox "nest" into one another like this)))) . The closest they can come to nesting is this))) . Result: no pattern packing . . . no blocking or screening of large areas of packing surface.

This greater degree of randomness in a packed bed, coupled with greater surface area per nominal sized unit means more free space, and more surface area available to liquor and gas. As a result pressure drop is substantially lower, flooding limits measurably higher — all around tower efficiency in terms of output and cost markedly improved.

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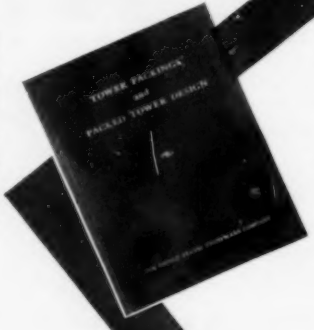

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358 D

TYPICAL DATA ON INTALOX* SADDLE PACKING

Nominal Size, Inch	Approximate Number per Cu. Ft.	Approximate Weight per Cu. Ft., Lb.	Approximate Surface Area Sq. Ft./Cu. Ft.	Percent Free Gas Space	Equivalent Spherical Diameter Dp, Inch
¼	117500	42	300	75	0.20
½	20700	34	190	78	0.32
¾	6500	35	102	77	0.48
1	2385	34	78	77.5	0.68
1½	709	30	59.5	81	0.96
2	265	33	36	79	1.38

**Trade name, The U. S. Stoneware Co.*

2,671,754 (Universal Oil Products Co.) Hydrocarbon conversion process providing for the two-stage hydrogenation of sulfur containing oils.
2,672,407 (Universal Oil Products Co.) Apparatus for contacting subdivided solid particles with different fluid streams within separate superimposed contacting zones.
2,672,489 (Gyro Process Co.) Pyrolysis of gaseous hydrocarbons for the production of unsaturated compounds.
2,672,490 (Standard Oil Development Co.) Catalytic dehydrogenation of butane with hot fluidized catalyst.
2,673,177 (Phillips Petroleum Co.) Process for destructive distillation of solid carbonaceous materials (shale).

Hydrocarbon Synthesis

2,671,013-4 (The Texas Co.) Method for producing a synthesis gas, using steam and metal carbide.
2,671,102 (M. W. Kellogg Co.) Separation of finely divided solids from gaseous suspensions thereof in reaction of CO with hydrogen.
2,671,103 (Rheinpreussen Aktiengesellschaft fur Bergbau und Chemie) Catalytic hydrogenation of carbon monoxide in liquid suspensions of catalyst.
2,671,104 (The Texas Co.) Process for producing motor fuel from synthesis product.
2,671,719 (Standard Oil Development Co.) Production of industrial gas mixture of hydrogen and carbon monoxide.
2,671,720 (Standard Oil Development Co.) Production of hydrocarbon synthesis gas.
2,671,721 (Standard Oil Development Co.) Production of industrial gas comprising carbon monoxide and hydrogen.
2,671,796 (Hydrocarbon Research, Inc.) Hydrocarbon synthesis and apparatus therefor.
2,672,402 (Godfrey L. Cabot, Inc.) Process of producing carbon black and synthesis gas.
2,672,410 (Standard Oil Development Co.) Gasification of carbonaceous solids to CO and hydrogen.
2,672,476 (Stanolind Oil and Gas Co.) Catalytic conversion of oxygenated organic compound mixtures.
2,672,849 (Hydrocarbon Research, Inc.) Synthesis gas generator.

PRODUCTS

Chemicals

2,671,010 (Ethyl Corp.) Sodium peroxide manufacture.
2,671,060 (Shell Development Co.) Unsaturated esters of substituted cyclohexanecarboxylic acids, polymers thereof, and compositions containing the same.
2,671,068 (Universal Oil Products Co.) Rubber-like materials and an unsaturated hydrocarbon oil from HF treatment.
2,671,073 (Standard Oil Development Co.) Modified butyl rubber.
2,671,090 (Standard Oil Co.-Ind.) Purification of phthalic anhydride.
2,671,107 (Sinclair Refining Co.) Catalytic dehydrogenation of aliphatic nitriles to unsaturated nitriles.
2,671,114 (Universal Oil Products Co.) Bis-hydronopyl ether and production thereof.
2,671,119 (Standard Oil Development Co.) Hydrogenation of oxo alcohol bottoms.
2,671,120 (Universal Oil Products Co.) Non-catalytic isomerization of aromatic compounds at 3000 psi.
2,671,121 (Standard Oil Development Co.) Preparation of 2-alkyl-1-alkenes.
2,671,336-7 (Universal Oil Products Co.) Hydrogen analyzer.
2,671,716 (Phillips Petroleum Co.) Process for the operation of an evaporative crystallization apparatus.
2,671,773 (Socony-Vacuum Oil Co., Inc.) Esters of thiophene-modified copolymers of maleic anhydride with aliphatic vinyl compounds.
2,671,774 (Standard Oil Development Co.) High extrusion modified isoolefin-multiolefin copolymers.
2,671,791 (Chempatents, Inc.) Process for the treatment of gases containing ethylene (oxidation).
2,671,804 (Phillips Petroleum Co.) Preparation and use of alkylene polyamine sulfenamides and thiosulfenamides.
2,671,812 (Standard Oil Co.-Ind.) Reaction of ozonides with Grignard reagents.
2,671,814 (Standard Oil Development Co.) Alcohol synthesis process.
2,671,815 (Universal Oil Products Co.) Manufacture of diarylalkanes.
2,672,425 (Standard Oil Development Co.) Heat treatment of hydrocarbon drying oils.
2,672,436 (Imperial Chemical Industries, Ltd.) Azeotropic distillation of xylenes.
2,672,438 (Shell Development Co.) Hydrochlorination of unsaturated organic compounds by electrical discharge.
2,672,439 (Shell Development Co.) Hydrobromination of olefinic compounds by electrical discharge.
2,672,440 (Shell Development Co.) Production of alcohols from olefinic compounds by electrical discharge and water vapor.
2,672,477 (Houdry Process Corp.) Process for preparing unsaturated nitriles from saturated nitriles.
2,672,485 (Shell Development Co.) Stabilization of alkyl phenol compounds.
2,672,487 (Standard Oil Development Co.) Para xylene separation process.
2,672,488 (Phillips Petroleum Co.) Partial oxidation of methane with oxygen.
2,673,193 (Shell Development Co.) Process for coagulating polymer latices prepared in a true aqueous emulsion.
2,673,195 (Shell Development Co.) Clathrate compound formation.
2,673,215 (Atlantic Refining Co.) Alkoxyalkylamine salts of alkyl-aryl sulfonic acids.
2,673,217 (Eastman Kodak Co.) Selective oxidation of substituted aromatic compounds using aldehyde-activated catalysts.
2,673,221 (Eastman Kodak Co.) Process of producing ethyl alcohol by hydration of ethylene.
2,673,222 (Standard Oil Development Co.) Separation of isomeric alcohols by selective acetalization.
2,673,224 (Sun Oil Co.) Alkylation of aromatic hydrocarbons by isoparaffinic hydrocarbons.
2,673,225 (Socony-Vacuum Oil Co.) Olefin separation, using silver nitrate.
2,673,226 (Phillips Petroleum Co.) Dechlorination of hydrocarbons containing organic chlorine, using $AlCl_3$ catalyst.

Fuels

2,671,718 (Surface Combustion Corp.) Continuous process for the manufacture of a supplement gas, using hydrocarbon vapor, air and steam.
2,672,408 (Shell Development Co.) Fuel oil blend of straight run and cracked oils and tert alkyl amine as stabilizer.
2,672,754 (Sun Oil Co.) Fuel weighing device.
2,673,144 (Standard Oil Co.-Ohio) Auxiliary alcohol-water fuel containing chelating agent and buffer.
2,673,145 (Shell Development Co.) High sulfur content fuel containing inorganic nitrate wear inhibitor.

Lubricants

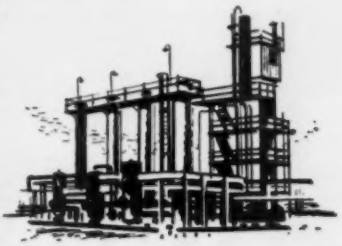
2,671,051 (Shell Development Co.) Low pour point lubricants containing wax with cyclic end group.
2,671,753 (Standard Oil Development Co.) Recovery of lube oil oxidation inhibitors, using tetrahydrofurfuryl alcohol and phenol extract.
2,671,758 (Shell Development Co.) Colloidal compositions and derivatives thereof (lube oil detergent).
2,671,759 (The Texas Co.) Rust preventive grease containing a polyvalent metal sulfonate and a wax oxidation product.
2,671,760 (United States of America-Sec'ty. Agriculture) High VI lubricating oil compositions containing vinyl acetate-vinyl palmitate copolymer.
2,672,446 (Standard Oil Co.) Lubricants containing copolymer of dialkyl itaconate.
2,673,174 (Pure Oil Co.-Ind.) Solvent refining to improve V.I. using phenol and ammonia.
2,673,175 (Standard Oil Development Co.) Synthetic hydrogenated lubricating oil.
2,673,183 (Standard Oil Co.-Ohio) Metal cutting oil derived from oxidized petroleum oil.
2,673,184 (Standard Oil Development Co.) Lubricating grease prepared from the esters of the dimer of linoleic acid.
2,673,185 (Standard Oil Development Co.) Polymerized carbonate ester lubricating oil additives.
2,673,196 (Standard Oil Co.-Ohio) Method of treating phosphorus sulfide-organic compound-metal derivative lubricant additives.

Specialties

2,671,036 (Standard Oil Co.-Ohio) Method of cleaning internal-combustion engines with cresol soap oil solution.
2,671,757 (Sinclair Oil and Gas Co.) Prevention of corrosion with ammonia neutralized sulfonated bottoms.
2,671,761 (Standard Oil Co.-Ind.) Flushing oil containing aromatic solvent plus ebony fat.
2,672,295 (Standard Oil Development Co.) Asphalt structure and method of preparing same for railroad crossings.
2,672,444 (Standard Oil Development Co.) Rust preventive compositions containing polyglycerol monooleate.
2,672,445 (California Research Corp.) Transformer oils (alkylene oxide liquid polymer) selenide and dihydroxy-anthraquinone synergist.
2,672,447 (California Research Corp.) Oxidation resistant transformer oils containing selenide and stabilizer.

problem

To meet ethylene consumer demand for a product that is essentially free of acetylene.



solution

GIRDLER developed catalysts to selectively hydrogenate the acetylene in the presence of the ethylene. Acetylene content was cut more than 99% giving consumers what they wanted:

Ethylene with less than 50ppm of Acetylene

Girdler will gladly help solve *your* catalyst problems.

FOR *Catalysts*

WRITE...

the **GIRDLER** *Company*

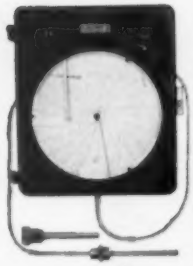
A DIVISION OF NATIONAL CYLINDER GAS COMPANY
Gas Processes Division
LOUISVILLE 1, KENTUCKY
NEW YORK • TULSA • SAN FRANCISCO

(To obtain more data on advertised products see page 776)

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

PALMER
MERCURY ACTUATED
Temperature Indicating
Instruments



RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG 200 G

PALMER
THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1500

2.672.448 (California Research Corp.) Transformer oil containing a tertiary alkyl phenol antioxidant and a dihydroxy anthraquinone as a synergist for the antioxidant.
2.672.976 (Parker Rust Proof Co.) Drawing lubricant compositions for phosphate-coated metals.
2.673.161 (Standard Oil Co.-Ind.) Corrosion inhibiting composition containing sulfonate and polymeric synthesis residue.
2.673.164 (Standard Oil Co.-Ohio) Process of treating asphalt with P5 compound to improve its adhesion.

Miscellaneous

2.670.624 (Standard Oil Co.-Ohio) Apparatus for measurement of low rate deformability of materials.
2.670.692 (Sun Oil Co.) Pumping system.
2.671.030 (Shell Development Co.) Method of preparing hydraulic cement having retarded setting action, using shellac.
2.671.035 (Phillips Petroleum Co.) Use of ion-exchange materials for removal of scale deposits from equipment.
2.671.340-3 (Standard Oil Co.-Ind.) Automatic vapor pressure measuring device.
2.671.652 (Phillips Petroleum Co.) Submerged-blast sparging apparatus.
2.671.741 (The Texas Co.) Decoking and cleaning tubular heaters.
2.672.191 (Sinclair Refining Co.) Multiple nozzle for directional flame control.
2.672.215 (Otto Schmid) Cyclone separator for separating solid particles from gases.
2.672.671 (Phillips Petroleum Co.) Alumina-mullite pebbles.
2.672.751 (Phillips Petroleum Co.) Automatic time-temperature curve apparatus.
2.672.758 (Standard Oil Development Co.) Preventing fluid pressure gauge hysteresis.

EQUIPMENT

Processing, general

2.670.848 (Shell Development Co.) Floating self-adjusting liquid skimmer.
2.671.053 (Shell Development Co.) Method and apparatus for high-vacuum distillation.
2.671.122 (Phillips Petroleum Co.) Multireactor pebble heater process and apparatus.
2.672.207 (Research Corp.) Electrical precipitator and extended surface electrode therefor.
2.672.208 (Research Corp.) Electrical precipitation apparatus.
2.672.271 (Technicon Chromatography Corp.) Control means for automatic fraction collection apparatus.
2.672.406 (Phillips Petroleum Co.) Apparatus for liquid-liquid contacting.
2.672.849 (Hydrocarbon Research, Inc.) Synthesis gas generator.
2.673.078 (Phillips Petroleum Co.) Sparging apparatus.

Catalytic Reactors

2.671.057 (Sun Oil Co.) Apparatus and method for contacting solids with gases.
2.671.796 (Hydrocarbon Research, Inc.) Hydrocarbon synthesis and apparatus therefor.
2.672.374 (Houdry Process Corp.) Solids lift disengager.
2.672.407 (Universal Oil Products Co.) Apparatus for contacting subdivided solid particles with different fluid streams within separate superimposed contacting zones.

Gaskets & Seals

2.672.357 (Crane Packing Co.) Hydraulically locked seal.
2.672.359 (Garlock Packing Co.) Sealing device.
2.672.360 (Garlock Packing Co.) Unitary rotary seal, including both stationary and rotatable sealing rings.

Instruments

2.670.574 (Utility Regulator Co.) Fluid pressure regulator.
2.670.624 (Standard Oil Co.-Ohio) Apparatus for measurement of low rate reformability.
2.670.625 (Atmotrol Corp.) Continuous reading specific gravity indicator.
2.670.878 (John J. Curry) Proportioning device.
2.670.989 (D. Napier & Son, Ltd.) Indicating or control apparatus responsive to temperature variations.
2.671.154 (Elias Burstein) Infrared detector.
2.671.203 (Minneapolis-Honeywell Regulator Co.) Pressure-to-electric transducer.
2.671.336 (Universal Oil Products Co.) Hydrogen analyzer.
2.671.337 (Universal Oil Products Co.) Hydrogen analyzer.
2.671.340 (Standard Oil Co.-Ind.) Vapor pressure device.
2.671.341 (Standard Oil Co.-Ind.) Continuous measurement of gasoline vapor pressure.
2.671.342 (Standard Oil Co.-Ind.) Vapor pressure determination by expansion cooling.
2.671.343 (Standard Oil Co.-Ind.) Vapor pressure by thermal conductivity.
2.671.645 (Shell Development Co.) Apparatus for rapidly mixing and controlling the temperature of immiscible liquids.
2.671.710 (Foxboro Co.) Recording instrument strip chart mechanism.
2.672.047 (John B. Pierce Foundation) High-temperature viscometer.
2.672.693 (Murray D. Cannell) Gauging attachment for tanks.
2.672.751 (Phillips Petroleum Co.) Automatic time-temperature curve apparatus.
2.672.757 (Buffalo Eclipse Corp.) Liquid-level gauge.
2.673.297 (Phillips Petroleum Co.) Analyzing and control device.
2.673.298 (Phillips Petroleum Co.) Recording infrared gas analyzer.

Pumps & Compressors

2.671.402 (Charles L. Pelham) Rotary pump.
2.671.404 (Florin Krueger) Turbine pump.
2.671.405 (Wellington L. Stoors) Cyclone pump.
2.671.406 (De Laval Steam Turbine Co.) Centrifugal pump.
2.671.410 (Gunnar A. Wahlmark) Gear pump.
2.671.411 (Marvin L. Rhine) Rotary pump or motor.
2.671.635 (Baldwin-Lima-Hamilton Corp.) Reversible pump-turbine.
2.671.604 (Westinghouse Electric Corp.) Multiple-stage, centrifugal refrigerant compressor.
2.671.606 (Ricardo & Co. Engineers, Ltd.) Compressor for air or other gaseous fluid.
2.672.276 (Nash Engineering Co.) Hydroturbine pump.
2.672.277 (Nash Engineering Co.) Hydroturbine pump.
2.672.282 (Camilo Vazquez Novas) Rotary vacuum and compression pump.
2.672.821 (Gorman-Rupp Industries, Inc.) Centrifugal pump.
2.672.822 (Gorman-Rupp Industries, Inc.) Self-priming certrifugal pump.
2.672.823 (Waterous Co.) Rotary pump.
2.672.824 (Gerotor May Corp.) Hydraulic pump or motor.
2.672.825 (Gerotor May Corp.) Hydraulic pump or motor.
2.673.026 (Carrier Corp.) Hermetic motor-compressor unit.
2.673.027 (Maximiliano Alvarez Lipkau) Rotary compressor.

Tanks & Vessels

2.672.254 (Chicago Bridge and Iron Co.) Liquid storage vessel.
2.672.409 (Koppers Co.) Telescoping lift-type gasholder.
2.673.001 (Graver Tank & Mfg. Co.) Cylindrical tank structure.

Valves & Fittings

2.670.749 (Hanovia Chemical & Mfg. Co.) Magnetic valve.
2.670.752 (W-K-M Co.) Double-disk gate valve having means to eliminate pressure lock.
2.670.756 (Albert J. Granberg) Impact-responsive flow regulator valve.
2.670.759 (Weatherhead Co.) Safety relief valve.
2.670.901 (Hartzell Industries, Inc.) Fluid mixing valve.
2.670.972 (Combustion Engineering Inc.) Tube and header joint.
2.671.471 (Paul A. Dewhirst) Angular flow control fitting.
2.671.652 (Phillips Petroleum Co.) Submerged-blast sparging apparatus.
2.672.882 (Theodore W. Bergquist) Safety valve.
2.672.886 (Standard Oil Development Co.) Air pilot valve.

Miscellaneous

2.672.130 (Universal Oil Products Co.) Circular updraft heater.
2.672.191 (Sinclair Refining Co.) Oil and gas-fired heater for refinery heaters.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25¢ each. Order by patent number direct from The Commissioner of Patents, Washington 25, D. C.

(To obtain more data on advertised products see page 776)

REFINERY PROCESS NEWS

PUBLISHED BY REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY MAY 1954

Four K. I. C. Projects Now Underway Involve Over $200 Million

Investment expenditures totaling the equivalent of over $200 million will be made by Kellogg's clients for just four of the many projects currently under construction by Kellogg International Corporation, Kellogg's wholly owned subsidiary for contracts outside the Americas. Already well along in construction, the projects include a vast gasoline-from-coal synthesis plant in South Africa; a complete catalytic refinery in Australia large enough to supply almost half that country's petroleum needs; a completely integrated, thermal combination refinery in Baghdad for the Royal Government of Iraq; and plants for producing phthalic anhydride and olefins for Montecatini, well known Italian chemical producer.

First Use of Synthol Process

The South African plant, under construction for SASOL (South African Coal, Oil, and Gas Corporation Ltd.) is expected to go on stream by the end of the year. When completed, it will produce gasoline, fuel oil, and a long list of by-product chemicals, using as starting material coal from virgin deposits near the plant site.

Kellogg's Synthol process, a unique step for catalytically reacting gases from the controlled combustion of coal, constitutes the heart of the entire operation. Additional gasoline is produced in subsequent steps when light hydrocarbons formed in the Synthol process are polymerized. The water soluble fractions—also produced in the synthesis step—are separated into their chemical components.

Refineries in Remote Areas

The two petroleum refineries are scheduled for completion in 1955. They underscore the tremendous undertakings involved in building self-contained industries in relatively unindustrialized parts of the world. For example, in addition to the actual 70,000 BPD refinery, the Australian project includes a

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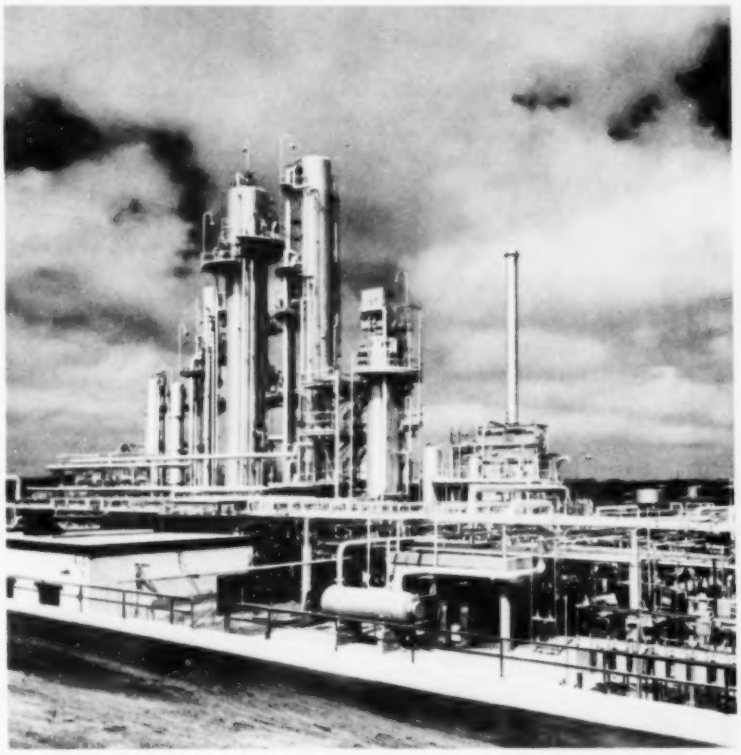

New Solvent Lube Plant Underscores the Efficiency and Quality Production of Improved Propane and Phenol Treating

Still on its initial run after 11 months on-stream, one of the world's most modern solvent extraction lube oil plants—designed and built by Kellogg for a Midwest refiner—has turned in an impressive operating record. High on the list of the plant's achievements are increased yields of premium products and an ability to maintain quality while processing feed stocks of lower-than-design specification.

Propane deasphalting and phenol extraction units are the heart of the plant. Both processes incorporate a number of design changes developed as a result of Kellogg's pilot-plant operations. For example, trays in the phenol extraction tower are of a special design which minimizes entrainment or "re-cycling." Because the two liquid phases settle or "de-mix" more effectively, this provides in effect an increase in the number of theoretical extraction stages. Still another design feature is incorporated in the phenol extraction tower to give a cleaner, sharper, more easily controlled interface between the liquids—a decided improvement over conventional versions of gravity extraction towers.

Some indication of the efficiency of the plant can be seen in some of the results obtained during test operations. From a reduced crude with 7.5 Conradson carbon, the propane deasphalter produced a yield of 75.6% deasphalted oil with 1.82 Conradson carbon. In the phenol extraction unit, a yield of 63.9% of

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REFINERY PROCESS NEWS

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New Lube Plant...

95.2 VI oil was obtained from a deasphalted oil charge, and a yield of 62.5% of 95.1 VI oil was produced from an 80 neutral feed stock.

The impressive performance of modernized propane deasphalting and phenol treating witnessed to date in the new plant is in logical sequence with Kellogg's earlier developments in both of these techniques. The company was the originator of "Tower Deasphalting"—now well known to all refiners as the process that radically changed the significance of the term "select crude." As a result of this development, asphalt content is no longer a measure of the potentiality of any crude for processing into premium lube oils.

A continuous low temperature operation that precludes cracking, tower deasphalting is now the accepted method for completely removing the asphalt from any crude in a single, economical step—and further—it uses as solvent a product the refiner already has at hand.

Counter-current extraction with phenol, an equally pace-setting development in lube processing, has become a standard method for improving the viscosity index and stability of all types of residuals as well as distillate oils. The ability of phenol to remove naphthenic acids thoroughly and to handle stocks of high sulfur content satisfactorily (without loss of solvent through chemical reaction) is one of its most important advantages.

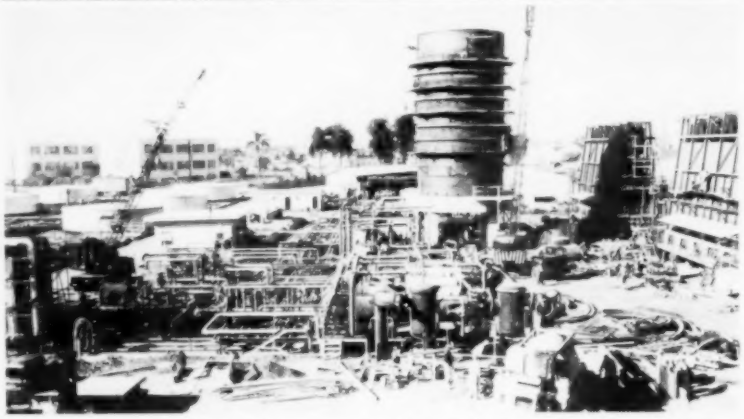
Some Facts About Delayed Coking

Did you know... that Kellogg has designed and built 63 per cent of the world's Delayed Coking capacity?

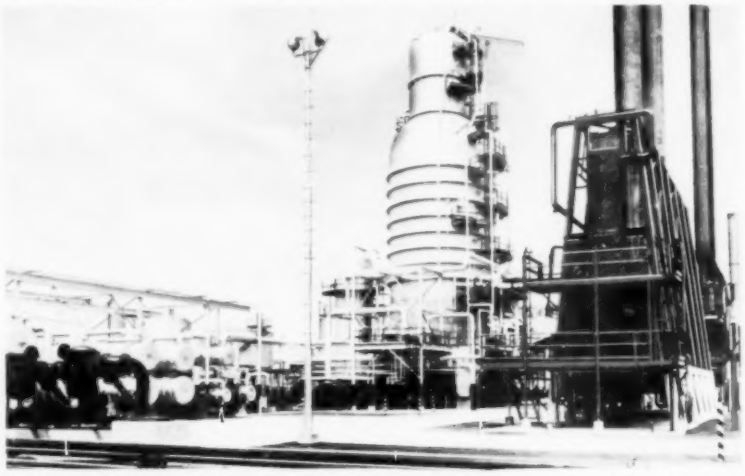
... that the world's largest Coker, built by Kellogg for a California refiner, has a throughput of 26,000 BDP, producing as by-product 1100 tons of coke per day?

... that process designs for Delayed Cokers have improved to such an extent that on-stream times of over a year may be readily obtained.

World's Largest Vacuum Flasher...



Above is shown the tower and furnaces for what will shortly be the largest Vacuum Flashing unit in the world—beating out by a slight margin the present title holder, shown below. Both of these Kellogg-built vacuum flashers are located at refineries of the Standard Oil Company of California, the new one at El Segundo, the other at Richmond.



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Over $200 Million...

1,700-foot pre-cast concrete jetty to accommodate ocean going tankers and two 17 mile pipe lines.

The two Montecatini projects are both unusual. The phthalic anhydride plant employs the Fluid catalytic process; the olefin plant produces ethylene and other olefins by the pyrolysis of gas oil and naphtha.

The South African and Australian projects, together with the 20,000 BPD refinery at Baghdad and the chemical plants in Italy, represent only a cross section of K. I. C.'s far-flung operations. From its London offices, the company supervises over-all construction, procurement, and labor recruitment for these as well as a score of other petroleum and chemical plants now building overseas.

For further information, technical data, etc., on any refining process, write

REFINERY PROCESS DIVISION

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

Also Jersey City, Los Angeles, Tulsa, Houston, Toronto, London and Paris

KELLOGG — PULLMAN

PERSONALS

Mr. Campbell

Dr. Belden

Mr. Piroomov

Mr. Schumacher

Donald L. Campbell, formerly chief process engineer of the Esso engineering department, has been appointed associate director of the Standard Oil Development Co.'s process division. Mr. Campbell received his bachelor's degree from Iowa State University and his master's from Massachusetts Institute of Technology. When he joined the development company in 1928, he was assigned to the general engineering department, which eventually became the Esso engineering department.

He was made head of the Esso engineering department's process engineering and economics division in 1946 and chief process engineer in 1949. Mr. Campbell has been actively connected with the design of some of the large refineries of the Standard Oil Development Co.'s affiliates and with the development of synthetic rubber and aviation gasoline during the war.

Replacing Mr. Campbell as chief process engineer with Esso is **Burton C. Belden.**

Dr. Belden was graduated from Hamilton College with a bachelor's degree in 1927 and was awarded his doctorate in chemistry by Cornell University in 1931. After five years with the United Color and Pigment Co., Newark, N.J., he joined the process division of the development company's Esso laboratories, and in 1947 was appointed an assistant director. During this period Dr. Belden has been associated with research on processing methods for lubricating oils and waxes.

R. S. Piroomov has been named an assistant director of the process division, Standard Oil Development Co. He was formerly manager of the technical service division, east coast manufacturing, Esso Standard Oil Co. Mr. Piroomov was graduated from M.I.T. with a bachelor's and master's degree in chemical engineering. He started with the development department of Jersey Standard in 1927 and, upon the formation of the technical service division of the present Esso Standard Oil Co., he was assigned to inaugurate the process control system.

He was appointed assistant manager of his division in 1945 and its manager in 1950. In addition to his other duties, Mr. Piroomov served as chairman of the manufacturing technical committee from 1944 to 1948.

Replacing Mr. Piroomov as manager of the technical service division, east coast manufacturing, Esso Standard Oil Co. is **F. William Schumacher,** formerly associate director of the development company's process division.

Shortly after graduation from Cornell University in 1930, when he was awarded a bachelor's degree in chemistry, Mr. Schumacher joined the Standard Oil Development Co. Most of his experience has been in the field of the development of petroleum refining process, particularly for lubricating oils and gasolines. In 1945 he was appointed assistant director, and in 1947 associate director of the process division.

Wilburn T. Askew, formerly assistant manager of Sun Oil Co.'s refinery at Marcus Hook, Pa., has been appointed general manager of the refinery. He succeeds Charles E. Maschal, who died February 17.

Mr. Askew began with Sun Oil Co. in 1931, immediately after graduation from Texas A. and M. College with a degree in chemical engineering. He continued as a chemical engineer in the research and development department at Marcus Hook refinery until 1943, when he was made foreman of a large refining unit built during World War II to make aviation gasoline for the armed forces.

He was appointed assistant superintendent in charge of gas recovery and alkylation a year later and continued in this capacity until his appointment as superintendent of the refinery in 1949. He became assistant manager in 1952.

C. Calvin Naylor has been appointed assistant to Mr. Askew. Mr. Naylor started with the company in 1934, after graduating from Pennsylvania State University. His first job was with the crude oil-testing laboratory of the research and development department. Since 1948 he has been operating assistant to the assistant superintendent in charge of catalytic cracking.

Walter C. Huffman, formerly general foreman of the company's petrochemical plant 17, has been named assistant superintendent in charge of petrochemicals. A graduate of Purdue University, Mr. Huffman joined the company's development laboratory at Marcus Hook in 1942. He became leader of the department's "cracking group" in 1943, directing development work on production of components and the blending of aviation fuels, and chief of the laboratory's technical service section in 1948.

Appointed to the post of operating assistant in the catalytic, gas and alkylation division is **William J. Devonshire, Jr.,** formerly general foreman at Plant 16.

Mr. Devonshire started with Sun Oil in 1932 as a test boy in the refinery laboratory, working up the ranks as a gauger, helper, shift foreman, day foreman and then general foreman.

Succeeding Mr. Huffman as general foreman at petrochemical plant 17 is **Calvin Stubbs,** formerly supervisory foreman there.

Mr. Stubbs began his employment with the company as a laborer in 1931, and was promoted to construction pipefitter's helper, turbiner, fireman, helper in a catalytic cracking plant, shift foreman, stillman and then assistant foreman of the company's catalytic cracking plant 12.

Mr. Gee

Mr. Baucum

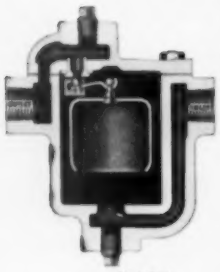
William P. Gee, assistant to the president, has been placed in charge of all petrochemical activities for The Texas Co. He also has responsibility for the company's activities in the field of synthetic rubber.

Mr. Gee represents the company as a director and member of the execu-

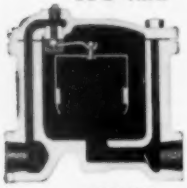
DOUBLE DRAINAGE

AT LOWER COST WITH Clark DUO-STEP Traps

FAMOUS DUO-STEP LEVERAGE IS NOW AVAILABLE FOR THE FIRST TIME ON THESE SMALLER SIZED STEAM TRAPS. GET HIGHEST DRAINAGE CAPACITY AT LOWEST COST.



CLARK 60-D TRAP



CLARK 70-D TRAP

Duo-Step is the revolutionary double fulcrum principle that affords maximum leverage to "crack" the valve from the orifice seat, teamed with "Follow-through" power that opens the orifice completely. This double action actually gives you double the drainage capacity of ordinary steam traps.

MODEL 60-D traps are of cast semi-steel construction, designed for pressures up to 200 P. S. I. and temperatures to 400°F. Duo-Step levers and brackets of stainless steel construction. Seats and discs are of Clark-loy. ½" or ¾" horizontal inlet and outlet connections with ¼" test outlet and drain plug. Vertical inlet can be furnished in ½" or ¾" size.

MODEL 70-D traps are of cast semi-steel construction, designed for pressures up to 200 P. S. I. and temperatures to 400°F. All working parts of stainless steel construction. Seats and discs are of Clark-loy. Horizontal inlet and outlet connections located at bottom of trap body for close-to-the-floor installations.

MODEL 70-TD for pressures to 150 P. S. I. and temperatures to 375°F. is available WITH BUILT-IN THERMAL BY-PASS at additional cost.

FOR COMPLETE INFORMATION CONTACT YOUR CLARK REPRESENTATIVE OR WRITE FOR *NEW* DUO-STEP BROCHURE

THE HOME OF DUO-STEP LEVERAGE

Clark

MANUFACTURING COMPANY

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tive committee of Jefferson Chemical Co., in which Texaco has a 50% interest. He entered the oil business in 1919 and was first employed by The Texas Co. in 1927 as a research chemist in the Port Arthur, Texas, refinery. In 1947 he was elected vice-president of Texaco Development Corp. in charge of process licensing, and remains a director of this company. In 1951 he was appointed assistant to the president.

A. W. Baucum, formerly assistant to the vice-president in charge of the producing department, has been promoted to assistant to the president. He started work for Texaco in 1934, after being graduated with a B.S. in petroleum engineering from Texas A. & M. In 1942 he was transferred to Tulsa as division petroleum engineer. Two years later he returned to Houston as assistant division manager of the south Texas division, and in 1948 he was appointed assistant to the manager of the producing department, Houston. He was transferred to New York in 1950.

Mr. Baucum is also a vice-president and director of the Texaco Exploration Co., a wholly owned producing subsidiary operating in western Canada.

In a third change of Texaco personnel **Dr. Paul S. Stutsman,** supervisor of chemicals research at Texaco's principal research laboratories at Beacon, N. Y., has been shifted to Mr. Gee's office to assist in over-all company activities relating to the development and production of petrochemicals.

Dr. Gustav Egloff, director of research for Universal Oil Products Co., has been selected to receive Germany's highest award in the field of mineral oil science, the Carl Engler Medaille for 1954. With the presentation next October, Dr. Egloff will become the first scientist living outside Germany to receive the award.

The ceremony will take place during the annual congress of the German Institute of Petroleum and Coal, to be held in Essen, West Germany. Following the congress, Dr. Egloff will make an intensive study of the latest advances in German chemistry. He also plans to give a series of lectures before universities and technical schools in West Germany.

Thomas Dudley Cabot has been elected president of Godfrey L. Cabot, Inc., Boston, Mass., chemicals manufacturing firm. Mr. Cabot has served as executive vice-president for a number of years. He succeeds Dr. Godfrey

(To obtain more data on advertised products see page 776)

L. Cabot, founder and president of the company for many years, who will remain chairman of the board.

Mr. Cabot is a graduate of Harvard University and holds honorary degrees from Tufts College, Northeastern University and Morris Harvey College.

Wallace F. Armstrong, formerly manager of the Ethyl Corp.'s Houston, Texas, plant, has been promoted to assistant general manager of manufacturing, a position recently created in the company.

Mr. Armstrong

Mr. Armstrong was born in Canada and holds both a bachelor's and master's degree in chemical engineering from the University of Florida. He joined Ethyl in 1939 as an operating supervisor, was named superintendent of ethyl chloride operations at the Baton Rouge, La., plant in 1945, and was promoted to manager of the Houston plant in 1952.

Other promotions in the company's manufacturing department involve **Glenn O. Hayes,** promoted from acting assistant manager at the Baton Rouge plant to manager of the Houston operations; **Melvin C. Hudgins,** from acting manager of maintenance to assistant manager of the Baton Rouge plant; and **James J. Bergin,** from superintendent of operations to assistant manager of the Houston plant.

Mr. Hayes has served at both plants in recent months as acting manager at Houston and acting assistant plant manager at Baton Rouge. A graduate of the Milwaukee College of Engineering, he joined the manufacturing department of Ethyl in 1938 and was named superintendent of sodium operations at Baton Rouge in 1945. He was promoted to manager of maintenance and on-plant construction in 1951 and acting assistant plant manager at Baton Rouge last September.

Mr. Hudgins was graduated from Louisiana State University in 1934 with a B.S. in mechanical engineering. He began employment with Ethyl in 1939, was appointed superintendent of maintenance in 1949 and acting manager of maintenance and on-plant construction at Baton Rouge in September, 1953.

Mr. Bergin is a native of Washington, D. C., and is a graduate of the Catholic University of America. He began with Ethyl in 1937 as an operating supervisor and served subsequently as assistant superintendent and superintendent of tetraethyl lead operations at Baton Rouge prior to his appointment as operations superintendent at the Houston plant in 1951.

Harold G. Owen, formerly process engineer at Continental Oil Co.'s Billings, Mont., refinery, has been appointed staff engineer of the company's petro-chemicals division, Houston, Texas. Before going to Billings, Mr. Owen was regional technologist for Continental's Rocky Mountain region, Denver, Colo.

P. S. Magruder, executive vice-president of General Petroleum, has been made chairman of the west coast oil industry's smog-study group, known as the smoke and fumes committee of the Western Oil and Gas Association. He replaces William G. Stewart, Jr., executive vice-president of Union Oil, under whose leadership the first formal smog research program was launched. The study is being carried out by Standard Research Institute at a cost of more than $1,000,000.

James F. McNamara has been named board chairman and president of Alox Corp., New York, producers of petrochemicals, with an operating plant at Niagara Falls. He is also chairman of Surpass Petrochemicals Ltd. of Canada, which recently purchased Alox. Mr. McNamara retired Dec. 31 as vice-president of International Nickel Co., Inc., with which he had been associated for 42 years.

Dr. William H. Bowman has been appointed vice-president in charge of operations of the Jefferson Chemical Co. In his new position Dr. Bowman is concerned with the manufacture and sale of the company's regular products. His responsibilities cover sales, production, purchasing and traffic.

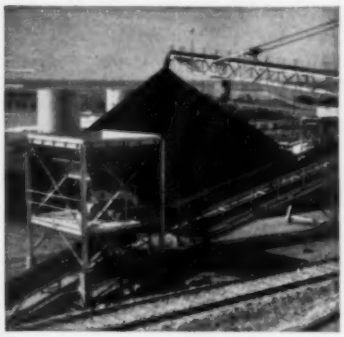
Dr. Max Neuhaus has been appointed the company's vice-president in charge of development of new products. His responsibilities include the company's research laboratories located at Austin, Texas, as well as engineering, market research and development, and related activities.

O. L. Clevenger, N. O. Felps, and **N. D. Jones, Jr.,** have each been promoted to the rank of senior mechanical engineer in the Baytown, Texas, refinery of the Humble Oil and Refining Co. In additon, **T. S. Fennema** has been given a promotion to engineering specialist at the refinery.

what's NEW in Engineering

A new, fast coupling for simplifying connections of tubing or piping, regardless of the size or purpose, is said to need no threading, flares, ferrules or tools to make the connection. A spring clip is pressed, the tubing is inserted, the spring is released and the connection has been made in one quick operation.

Sticky to dry bauxite in 13 miles and how to handle it effectively at both ends was just one problem facing Kaiser Engineers in developing mining facilities in

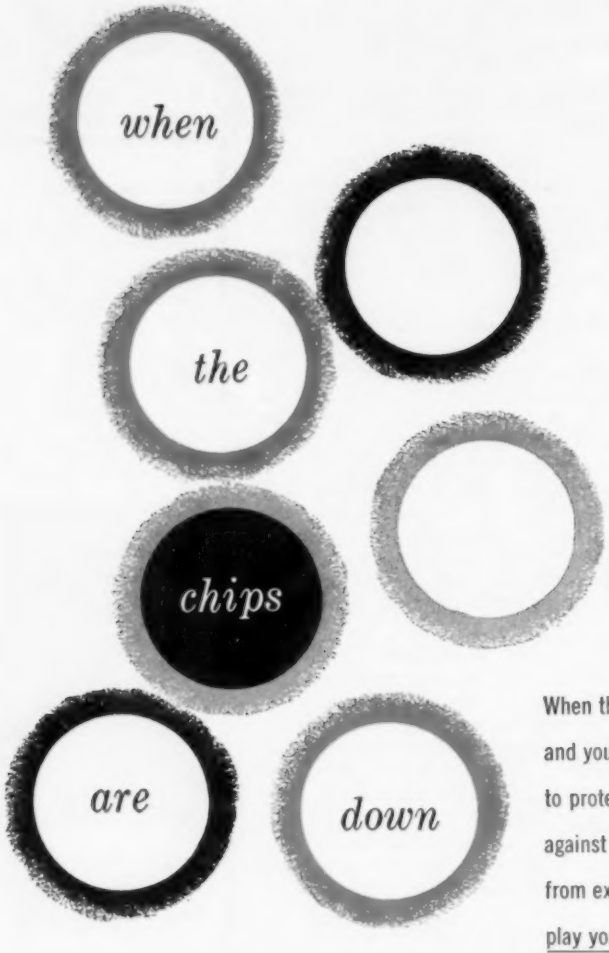


Jamaica. Self-heating truck bodies and other specially designed handling methods licked this problem. At the same time, the versatile talents of Kaiser Engineers were focused on all other facilities at the island mine: housing, drying, storage, a 995-foot dock, 13 miles of railroad and a 1,000 ton-per-hour conveyor loading system being just a few of them.

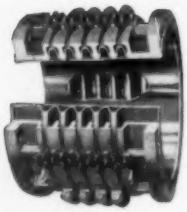
Chemical Business Handbook, just published, is the title of a valuable new book edited by John H. Perry. It is a reference book of modern business management keyed especially to the needs of the chemical and chemical engineering industries.

When it comes to research, preliminary engineering studies, engineering design and layout, estimating, preparation of specifications, construction programming, negotiation of contracts, and procurement and expediting of materials and equipment – call or write: Kaiser Engineers Division of Henry J. Kaiser Company, Kaiser Building, Oakland 12, California.

(To obtain more data on advertised products see page 776)



When the chips are down
and you must hold a winning hand
to protect expensive piping and equipment
against stress and strain
from expansion and contraction—
play your ace!
Count on Zallea Duo-Equalizing Expansion Joints.
Their life expectancy has been proven
40% to 1800% better than any self equalizing—
or other type of packless—expansion joint made!
So specify—and insist on Zallea!



Zallea already has, or will make, expansion joints for every service. For information on standard types, request Bulletin 351.

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expansion joints

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World's Largest Manufacturers of Expansion Joints

UNIVERSAL OIL PRODUCTS CO.'S RESEARCH CENTER at Des Plaines, Ill., seen above in an artist's sketch, is under construction and due to be completed by the middle of next year. It is located next to the company's new administrative and engineering building and is part of Universal's plan to bring administrative, engineering, research and development operations into one geographical area. Research laboratories are all on the north side of the building to insure the best light, and offices are being located on the same floor as related laboratories. The building will be completely air conditioned

New Marley Plant in Louisville

A new plant in Louisville, Ky., was opened recently by the Marley Co. for production of the firm's line of "Aquatowers," mechanical draft cooling towers for air conditioning and refrigeration service. The new plant replaces the company's former facilities in Louisville.

Occupying 10 acres, the plant provides 77,000 sq. ft. of production space, and the company has an option on an additional four and one-half acres if further expansion proves necessary. Besides the "Aquatower" line the new plant is equipped to make counterflow towers for large capacity water-cooling service and the company's line of air-cooled heat exchangers.

Dresser Companies to Relocate

Clark Bros., of Olean, N.Y., an operating subsidiary of Dresser Industries, Inc., will move its operations in Tulsa, Okla., early this summer from their present location to another site in Tulsa recently purchased by the Dresser company. The Clark firm, a manufacturer of electric, steam and gas engine-driven compressors will establish its regional sales and service engineering offices and warehousing, with a complete parts depot, on the new location at Sheridan Road and 15th St.

Another Dresser subsidiary to be affected by the move is Pacific Pumps, Inc., of Huntington Park, Calif., which will establish centralized regional sales and service offices and reconditioning facilities for its line of oil well plunger pumps, as well as regional sales offices for Pacific's centrifugal pump line.

Future plans call for other Dresser operating companies to be moved to the new Tulsa location, so that it will eventually house a representative group of the firm's member companies.

Marlow Opens Texas Plant

A branch manufacturing plant at Longview, Texas, has been established by Marlow Pumps, a division of Bell & Gossett Co. The new plant, 125 miles east of Dallas, will give the Marlow firm easier access to the east Texas region, and the company's plant in De Queen, Ark., will be shut down and its operations transferred to Longview.

The Longview plant will manufacture the complete line of Marlow pumps and will maintain a balanced stock of all type pumps and parts.

Dix Receives Speller Award

Edgar H. Dix, Jr., assistant director of research, Aluminum Co. of America, is the recipient of this year's Frank Newman Speller Award of the National Association of Corrosion Engineers.

Presentation of the award to Mr. Dix is recognition of his outstanding work for more than 30 years in the field of corrosion engineering with aluminum and magnesium at Alcoa's aluminum research laboratories.

Mr. Dix began his work with Alcoa in 1919. His primary interest has been the development and metallurgy of the aluminum alloys. Much of his work, particularly in the area of corrosion resistance, has been in the development of aircraft alloys.

The theory of intergranular corrosion of heat-treated aluminum alloys, now generally accepted in the metallurgical field, was first proposed by Mr. Dix and his associates in 1928.

A patent for corrosion-resistant aluminum materials, which became known as Alclad products, was granted to Mr. Dix in 1932. Alclad aluminum products are clad with aluminum of a composition that provides "built-in" corrosion resistance for the core material.

MMM Opens Canadian Branch

Manufacturing operations in Canada were opened recently by Manning, Maxwell & Moore of Canada in space leased from the Canada Machinery Corp., Ltd., on Water St. South, Galt, Ontario. Production is planned of the company's line of pressure gages, safety and safety relief valves and bronze and steel valves in gate, globe, angle, "Flocontrol" and other types. Executive offices of Manning, Maxwell & Moore are in Stratford, Conn.

President of the new Canadian firm is Hamilton Merrill, and Chester H. Butterfield and Colby M. Chester III, are vice-presidents.

Selas Furnaces for Gulf Plant

The Selas Corp. of America has begun construction on eight radiant-heat furnaces for the new Gulf Oil ethylene plant at Port Arthur, Texas, which Gulf spokesmen say will have the world's largest ethylene producing capacity, estimated at seven billion cubic feet annually.

The refinery is being constructed by Stone and Webster's Badger Process Division, with the Selas firm furnishing the heat units. The furnaces are designed to produce temperatures up to 1550 degrees but yet allow for heat control along the tubing which carries the gas during the heating process.

Cooling Tower Group Elects

Neal B. LauBach, Hudson Engineering Corp., Houston, Texas, has been elected president of the Cooling Tower Institute, an association of manufacturers of industrial water-cooling equipment.

Other new officers are: Paul R. Hoffman, Lilie-Hoffman Cooling Towers, Inc., of St. Louis, vice-president; Clayton E. Pickup, Fluor Corp., Ltd.,

for dependable, trouble-free control
"of hard-to-hold" fluids . . . . .

SPECIFY
HOMESTEAD
Lever-Seald
VALVES

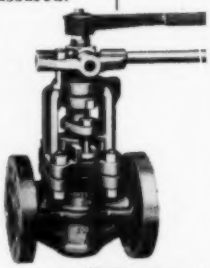
they provide sure shut-off . . .

ARE STICK PROOF . . . OPERATE INSTANTLY

A positive, drop-tight seal and instant, stick-proof operation under all fluid, temperature or pressure conditions, is assured by the exclusive, built-in, Homestead Lever-Seald mechanism. This powerful lever-and-screw device not only presses the valve's tapered plug firmly into its seat to form a drop-tight seal, but also provides a positive means of relieving seating pressure just enough to overcome friction and permit easy operation. And because all operating parts and valve seating surfaces are fully protected in both the open and closed positions from the corrosive or erosive effects of line fluids, long, dependable, trouble-free service is doubly assured.

If "hard-to-handle" fluids are your problem, specify Homestead Lever-Seald Valves for your next installation or as replacements. You'll be glad you did.

We make them in metals and alloys to specification in sizes 1½" to 12", for pressures from vacuum to 1500 lbs., and for temperatures from 40° below zero to 1100°F. Dry seat, or pressure gun lubricated optional.



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Los Angeles, secretary; and Robert R. Pabodie, United Cooling Tower Co., Kansas City, Mo., treasurer.

F & P Build Mobile Demonstrator

A complete process instrumentation system for demonstration and training has been installed by the Dallas personnel of Fischer & Porter Co. in a conventional trailer for convenient towing by passenger car to customers' plants and offices. Completely self-contained, the unit needs only to be hooked to a lighting main capable of furnishing 1500 w. at 110 v. to demonstrate most F&P instruments and control valves in action.

All control functions and performances may be demonstrated separately —temperature, pressure, flow, liquid level and proportioning. Instruments also may be interconnected in various cascade arrangements to simulate process requirements.

The mobile demonstrator has been designed principally for process engineers, operators and technical service personnel who have occasion to buy, specify or use instruments but who usually do not have the opportunity to secure first-hand information on instrumentation principles. The trailer will accommodate a seated audience of up to 10 people.

Personnel Changes

Patterson Foundry and Machine Co.—Kenneth S. Valentine, formerly New York manager, to his own business as manufacturers' representative.

Kaiser Engineers—Robert M. Cornforth to refinery sales manager at Oakland, Calif., from sales manager with W. M. Barnes Co., Los Angeles.

Babcock & Wilcox Co.—Edward A. Livingstone to the board of directors; he was also placed in charge of the tubular products division.

Combustion Engineering, Inc.—R. C. Ulmer to head of the research department, succeeding B. J. Cross, who has retired.

Southwest Research Institute—William D. Thomas to fuels and lubricants technologist from American Cyanamid Co.'s petroleum chemical department.

Continental Electric Equipment Co.—Murray C. Nelson to regional manager of the area including Maryland, the District of Columbia and Virginia; Thomas Kelly to manager of the east-

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WHY NOT USE IT?

Fuel costs getting you down? In a year or so, a Ljungstrom Air Preheater could pay for itself in fuel savings alone.

Trying to boost your capacity? Four of your present units could do the work of five with Ljungstroms on the job, increasing each unit's output as much as 25%.

Turnaround taking too big a slice out of on-stream time? A Ljungstrom Air Preheater makes fuel burn more completely – at a higher temperature – greatly reducing the rate of slag build-up on furnace tubes. You'll stay on-stream longer – year in and year out – with a Ljungstrom.

Our Engineering Staff will be happy to show you how others have saved up to 20% on their annual fuel bills . . . increased throughput as much as 25% . . . reduced slagging and actually improved product octane ratings with Ljungstrom Air Preheaters. Write today for full details.

WHEREVER YOU BURN FUEL, YOU NEED LJUNGSTROM

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

(To obtain more data on advertised products see page 776)

"RETAINED VOLATILITY" Seasons

YOUR MOTOR FUEL

Make certain your Motor Fuel loses none of its high quality before or after it gets into the customer's tank.

Blending with NATURAL GASOLINE will "season" your product with RETAINED VOLATILITY.

You can depend on WARREN'S production, transportation, storage and SERVICE for the quality and quantity of NATURAL GASOLINE you need — when and where you want it.

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ern Pennsylvania, southern New Jersey and Delaware region.

Rockwell Mfg. Co.—Robert M. Farrell, to sales engineer for the Meter and Valve Division in the Houston office.

The Lummus Co.—C. E. (Todd) Lightfoot to the firm in the New York offices.

Worthington Corp.—B. R. McBath to general European manager, with headquarters at the company's offices in Paris, France.

C. & G. Sales & Engineering Co.—Vernon Barnes to the sales application staff of this manufacturers' agent in Milwaukee, Wis., for the Reliance Electric & Engineering Co.

Hammond Iron Works—Max G. Walker to sales manager for the south eastern United States, with his headquarters in the firm's Birmingham, Ala., plant.

Orbit Valve Co.—Earl N. Stone, from Kansas representative to Denver, Colo., office. He will represent the firm in Colorado, southern Nebraska, Utah and northern New Mexico.

The Colonial Iron Works—P. J. Kern, Jr., to the staff as head of the Karbate Service activities.

Kaiser Steel Corp.—A. L. Peake, Jr., to assistant sales manager, southern district, Los Angeles; A. G. Grey to assistant sales manager, central district, Oakland.

U. S. Steel—Roy V. Claytor to district representative, refinery and pipe line equipment sales of the company's Oil Well Supply Division at Hobbs, N. M.

Rockwell Mfg. Co.—Terrence H. M. Taylor, from research scientist with the U. S. Atomic Energy Commission to chief engineer of the Nordstrom valve division plant at Oakland, Calif.

Panellit, Inc.—Millard D. Shriver to general sales manager, with responsibility for sales activities of Panascan division and Panalarm Products as well.

Celanese Corp. of America—William L. Milheim to sales manager of southeastern district, with offices in Charlotte, N. C.; W. D. Matthews to mid-Atlantic district manager, with offices in New York; J. W. Morton to metropolitan district manager, in New York; and William B. Sinclair to district manager for New England, with headquarters in Boston, Mass.

Branches, Distributors

North American Philips Co., has appointed W. A. Schlueter southwest dealer for products of the research and control instruments division. The organization is known as the Southwestern Electronics Corp. and occupies a building at 3920 S. Peoria Ave. in Tulsa, Okla.

The Pittsburgh Lectrodryer Corp. has appointed the Ben McKalip Co., of Tulsa, Okla., product distributor in the Oklahoma, Kansas and Texas Panhandle territory.

Clark Bros. Co., Olean, N. Y., has opened a sales office at 930 Texas Eastern Bldg., Shreveport, La. James R. Hutton is the sales engineer at the new office.

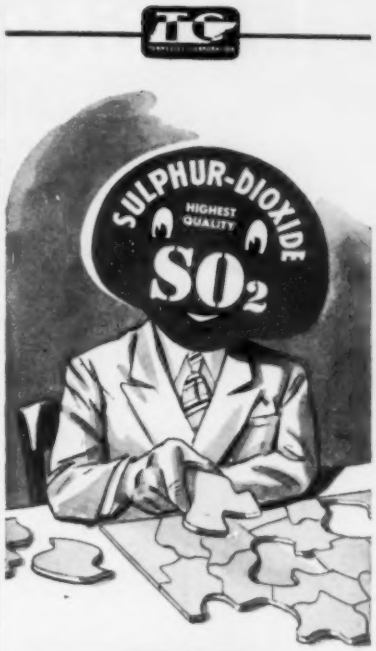
Expansion, Transition

Mathewson Corp., Inglewood, Calif., is entering the field of special valve design and manufacture. The firm will concentrate for a time on swing and disc-type check valves, vent, line, etc., which are specially designed for high temperatures, synthetic oils, fuels and chemicals.

Hammond Iron Works, Inc., is engaged in expansion of its Casper, Wyo., plant, to double its output of oil storage and processing tanks. The expansion will cost $200,000, and the excellent prospect for business in the Rocky Mountain area was cited as the reason for the move.

Wallace & Tiernan Co., Belleville, N. J., and Novadel-Agene Corp. have merged into a single organization known as Wallace & Tiernan, Inc. The merger is expected to enhance the new company's stability by diversifying its operations. The Wallace & Tiernan firm manufactures chemical feeders, materials-handling equipment, pressure sensitive instruments and a number of pharmaceuticals. The Novadel-Agene Corp. makes a range of items in the flour-milling and chemical fields.

Tank Service, Inc., of Tulsa, Okla., has moved into its own building at 3319 North Lewis, from its former location in the Rialto Building. The new location offers both office and shop facilities.



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Perhaps your industry has a particular process that requires a superior reducing or bleaching agent, preservative, antichlor, pH control, or neutralizer. Tennessee's highest quality Sulphur Dioxide will fit the need. In most operations, the use of this chemical (SO_2) with its manifold uses results in more efficiency and increased economy. We can supply Tennessee's highest quality Sulphur Dioxide in cylinders, ton drums, tank cars, and tank trucks. Let our technical experts show you how you might employ it to your greatest advantage.

SULPHUR-DIOXIDE
HIGHEST QUALITY
SO_2

- Cylinders
- Ton Drums
- Tank Trucks
- Tank Cars

Samples, Specifications and Detailed Information on Request.

TENNESSEE TC CORPORATION

617-29 Grant Building, Atlanta, Georgia

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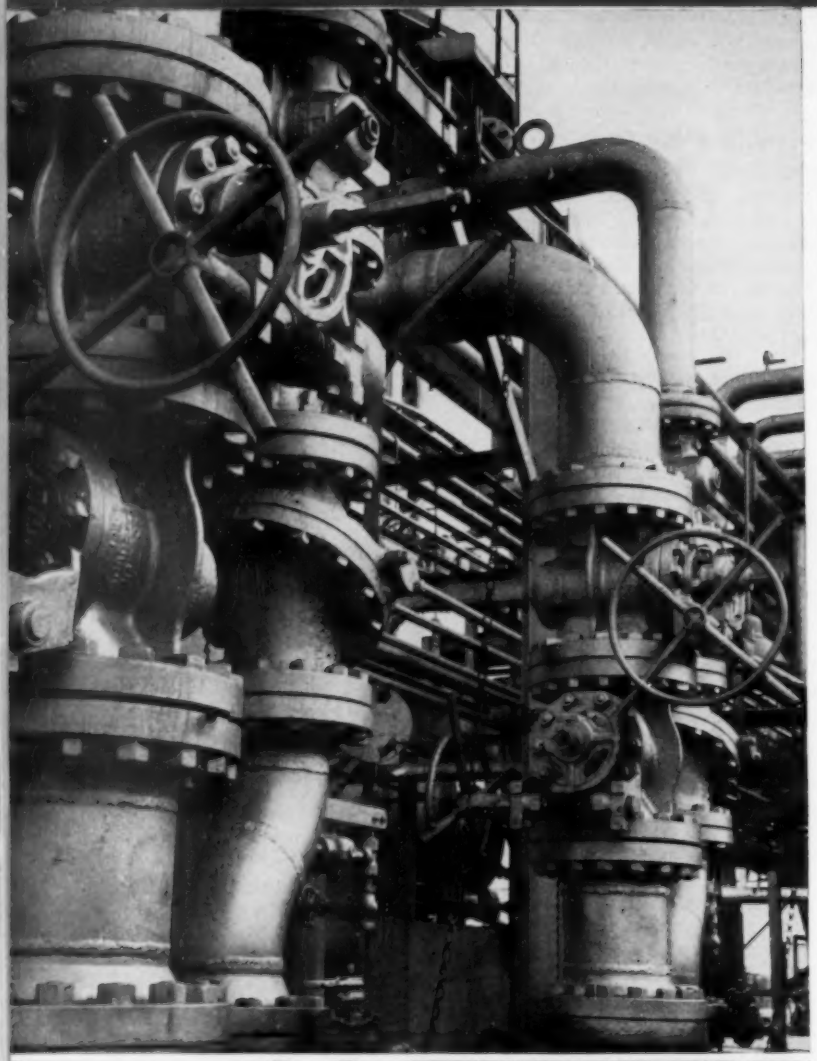
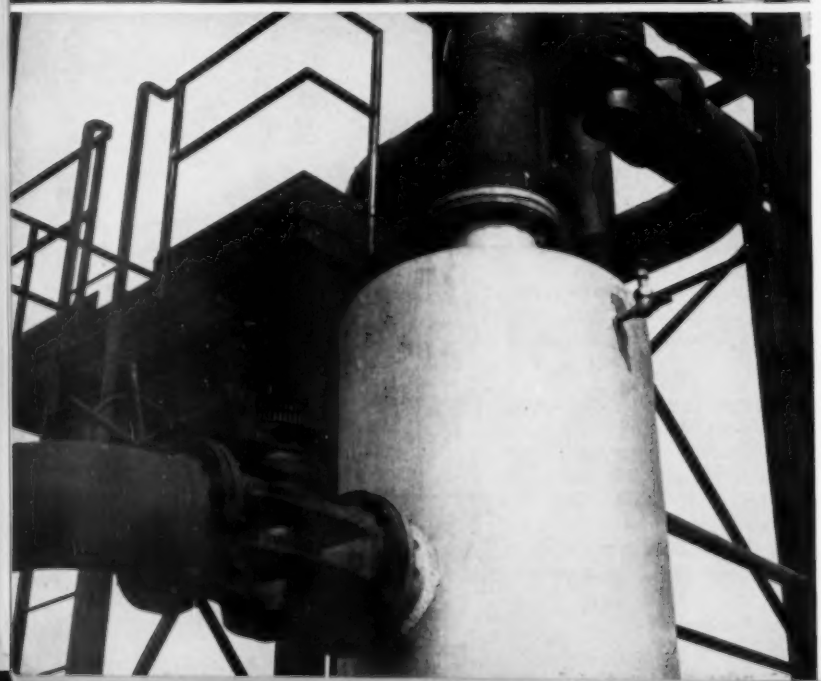
Lubricant MAKES THE DIFFERENCE





NORDSTROM VALVES

CUT MAINTENANCE ON COMPLEX REFINERY SERVICES

No question about it—proper maintenance of Nordstrom lubricated valves costs very little compared to the major repair and replacement costs of ordinary valves in complex refinery service.

Look into a Nordstrom valve and you'll see why—

1. **Lubricant protects plug and body against abrasion and galling. That means longer valve life.**
2. **Lubricant permits sliding rather than wedging.**
3. **Lubricant makes the valve self-cleaning. If dirt is lodged between plug and body, lubricant and the rotary action of the plug free it in a turn or two.**
4. **Lubricant keeps the valve ready to turn in an emergency.**

Nordstrom makes the proper lubricant for each refinery service, too, perfectly complementing the wide range of sizes, types and pressure classes in the Nordstrom line.

You'll save money, you'll avoid shut-downs, you'll have easier valve operation throughout the refinery if you standardize on Nordstrom valves and genuine Nordstrom lubricants. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

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Rockwell

Nordstrom **Valves**

Lubricant-Sealed for Positive Shut-Off

Another Rockwell Product

Report on Oil Company Integration Traces Decline of Small Refiner

The Growth of Integrated Oil Companies, by Prof. John G. McLean and Asst. Prof. Robert W. Haigh; 8½x11½ in., 728 pp., stiff cloth cover, $12. Division of Research, Graduate School of Business Administration, Harvard University, Boston, Mass.

THROUGHOUT its history, the oil industry has been under strong pressure to integrate.

A concurrent development revealed in a new Harvard University research report is the decline of small refiners in the last 30 years. Their share of the nation's refining capacity has dropped from 28 to 15% of the total.

In the exhaustive study of the important factors involved in the growth of large integrated oil companies, special attention is devoted to the problems of the small non-integrated refineries. Despite the decline of their share of the nation's refining capacity, however, the report sees "many profitable fields open to small firms, provided they select situations well suited to the financial and managerial resources at their command."

Prof. John G. McLean and Asst. Prof. Robert W. Haigh base their report on a study of 106 oil companies. These represent 59.2% of the operating refining companies and 94.7% of the refining capacity of the country. Moreover a detailed analysis was made of data from the files of seven representative companies: Gulf Oil Corp., The Texas Co., Sinclair Oil Corp., Ohio Oil Co., Atlantic Refining Co., Standard Oil Co. (Indiana) and Standard Oil Co. (Ohio).

Decline Is "Natural"—The authors see the declining role of the small refinery as an appropriate and natural part of the evolution of the industry. The decline could have been avoided only by placing strong, artificial restraints on the economic, technological and competitive forces at work in the industry.

One important key to the small refiner's loss of position has been found to be the rapid advances in technology. Such developments have forced refiners continuously to invest large sums in new plant facilities. Small refineries often have not had the necessary capital. Or if they had it, they preferred to keep it as profit.

This factor is seen as an important contribution to the growth of large integrated oil companies. The size of the investment required for such facilities as a refinery or a pipe line requires large capital.

Market Assurance—A refinery's use is solely for the processing of crude oil. And the authors make the point that no company can afford to invest that much money unless it is assured of both a dependable source of crude oil and a market for the product. As they put it, this has led to integration "backward" to production and "forward" to wholesaling and retailing.

The study shows that at least 48.6% of the nation's refining companies have some kind of integrated structure. Such companies hold 93.2% of the refining capacity in the country, 85.4% of the crude oil gathering lines, 82.1% of the crude oil trunk lines and 92.2% of the products pipe lines.

Research indicates, however, that integration tapers off at the "ends" of the oil process. These integrated companies have only 7.7% of the drilling rigs, 35.4% of the producing wells and 51.6% of the service stations.

Laws Restrict Supply — Professors McLean and Haigh find another major contribution to the decline of the small refiner in the development of oil conservation laws. The authors assert these laws tended to remove the large quantities of cheap crude oil which had from time to time accompanied the discovery of new oil fields. These often created a profitable field of opportunity for the small, oil field refiner. The conclusions are based on studies of the circumstances causing the entry and exit of small refiners in the East Texas field after 1930 and in the Illinois Basin after 1938.

Still another reason for the declining role of small refiners has been the general success that has accompanied vertical integration as a means of meeting the particular business and economic risks associated with oil industry operations. For a variety of reasons, the authors find, the small firms have lagged behind the larger ones in the use of integration.

The authors conclude it is understandable that the small firms should have suffered a gradual loss in position, compared to the large companies that were ready and willing to undertake integration when and where it could be used to advantage.

Competition Hurts Refiners — The continuing pressure of competititon has also had its effect on the small refiner. Had competition in the oil industry been generally weak and ineffective, these refiners would have suffered no particular hardship from technological and economic conditions. Circumstances such as these, say the authors, compel adjustments in industry and corporate structures only when the pressure of competition is strong.

Opportunities Open — Despite the decline that has taken place in the proportionate position of the small refiner, Professors McLean and Haigh find that there are many profitable fields still open to small firms. Such companies have been particularly successful when they have elected to operate in segments of the business that are of little interest to the large firms, or in which the larger companies are ill-equipped to compete.

New Handbook Gives Insulation Specs

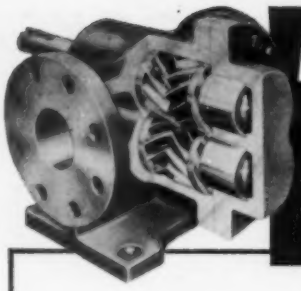
THE FOURTH edition of the handbook "Mineral Wool Insulation Specifications and Standards" has been published by the Industrial Mineral Fiber Institute, Inc., New York. The book is designed to serve engineers, specifications writers, superintendents, etc., as a guide to proper selection of insulation materials and as a basis for insulation specification within industry itself.

The 24 specifications and standards include seven by the American Society for Testing Materials, two by U. S. Maritime Commission, eight federal specifications, three commercials standards, and four military specifications on clothing and other supplies. Each specification is listed in the index under type of mineral wool insulation and type of service (high or low temperature).

The handbook is bound in a heavy cover, and copies of it may be obtained, at $3.50 each, by writing the executive director, Industrial Mineral Fiber Institute, Inc., 441 Lexington Ave., New York City.

New Butadiene Safety Sheet Issued by MCA

A SAFETY data sheet giving the properties and essential information for safe handling and use of butadiene has been issued by the Manufacturing Chemists' Association. Butadiene is a chemical widely used in the manufacture of rubber products. Its fumes have a mildly toxic effect on the eyes, nose, throat and lungs, though this can be serious if the con-



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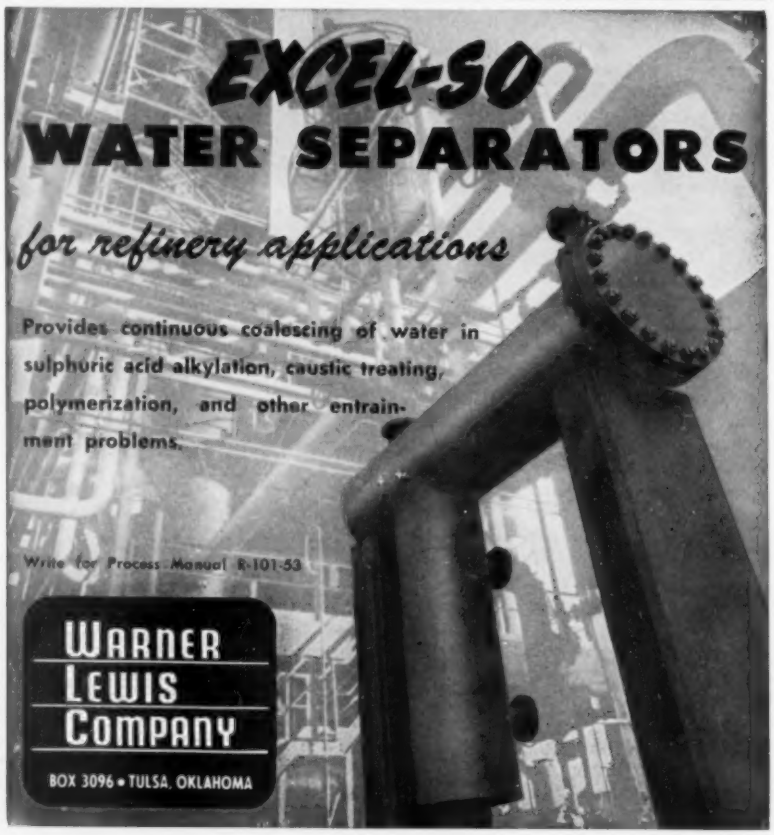
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centration of the vapor is high enough.

The safety sheet sets out its information in summary form, beginning with the substance's physical and chemical properties, grade and strength; containers and labels to be used for ordinary shipping; and the fire and health hazards attendant on unloading and emptying containers.

Later sections deal with the precautions to be observed when storing butadiene, the vessels and piping best used for storage and safety equipment needed; precautions necessary when using the chemical for industrial purposes; personal protective equipment; and waste disposal of mixtures containing butadiene. The final section of the 16-page sheet reviews the hazards to health and the methods of control, including specific first-aid treatment.

The data sheet, No. SD-55, may be obtained for 25 cents from the Manufacturing Chemists' Association, 246 Woodward Bldg., 15th and H Sts., N.W., Washington, D. C.

Rotameter Book Offers Operation Shortcuts

A WORKBOOK designed to make using the rotameter simpler and more accurate has been published by the Brooks Rotameter Co. The mass of data included provides short cuts to accurate size selection and flow correction, with correction factors for both temperature and pressure; and charts and tables covering the full range of float materials, rotameter tube sizes, specific gravities and temperatures, all of which have been charted in every common unit of flow measurement. All flow rate tables include an "Actual Flow Factor" which yields the actual rate of flow under any new liquid specific gravity-float material conditions.

Among the tables included in the work are six of liquid standard flows in English and metric, volumetric and gravimetric units; 17 tables of flow correction and size selection factors; correction factors for individual gases and gas mixtures; conversion factors; theory of the rotometer, derivation of flow formulas; 38 calibration curves for both air and water; liquid specific gravity correction curves, and temperature and pressure correction curves.

The handbook consists of 250 single sheets and costs $20. Additions and corrections will be made at no charge for three years after purchase. Copies may be obtained from Brooks Rotameter Co., Lansdale, Pa.

(To obtain more data on advertised products see page 776)

AIChE Will Feature Three Symposiums

SYMPOSIUMS on process design, cost controls in operation and polymeric materials of construction will highlight the national meeting of the American Institute of Chemical Engineers, to be held May 16 to 19 at the Hotel Kimball in Springfield, Mass.

The symposiums are planned as part of three of the meeting's five technical sessions, beginning with the session on Monday morning, May 17. The symposium on process design will include an analysis of the principles of batch and continuous operation, a discussion of extrapolation limits for process equipment, a report on the influence of contaminants on process design and economics, and one about the process design of light hydrocarbon cracking units.

The second technical session, Monday afternoon, will consist of papers on the theory and practice of continuous pressure filtration, the role of porosity in filtration, the flow of non-Newtonian fluids in circular conduits, an automatic laboratory distillation column and its operating characteristics, and European designs of electrolytic cells for the manufacture of chlorine and caustic.

"Cost Controls in Operation" is the symposium which will lead off the Tuesday morning technical session. Papers on this topic will include: "Control of Research Costs," by M. T. Carpenter, Standard Oil Co. (Ind.); "Controlling Costs in Construction," by Ralph E. De Simone, New York; "Reducing Costs by Application of Statistics," by Leonard A. Seder, Malden, Mass.; and "Controlling Costs in Production," by David E. Pierce, Diamond Alkali Co., Cleveland.

The final symposium, on polymeric materials of construction, will be held the same afternoon. Speakers to be heard at that time will examine the properties of a number of these materials, such as vulcanizable elastomers, thermosetting resins, vinyl plastics, polyethylene, polytetrafluorethylene, polymonochlorotrifluoroethylene, acrylic resins and cellulosics.

The final technical session will be given on Wednesday morning, May 19, and the group will hear papers read on cocurrent gas absorption, liquid film efficiencies on sieve trays, a system of compensation for hydraulic gradient by bubble cap staging in a large fractionating tower, and two reports on the performance of packed columns.

Symposium on Testing Liquefied Petroleum Gases

FOUR association groups will sponsor a 2-day symposium on methods for testing liquefied petroleum gases at the Statler Hotel in St. Louis September 27 and 28, 1954. The program will offer papers on all phases of LPG testing with contributions anticipated from consumer groups. Field tests and any test methods providing significant information are particularly desired.

Sponsoring organizations are the Amercan Society for Testing Materials' committee D-2 on petroleum products and D-3 on gaseous fuels, California Natural Gasoline Association and Natural Gasoline Association of America. A number of other trade associations and regulatory bodies have been invited to assist.

To insure sufficient time for assembling the program, titles, authors and abstracts of proposed papers should be in the program committee's hands no later than March 15, 1954, with drafts of papers to follow no later than June 1. Those desiring to contribute papers or needing further information are requested to contact B. J. Heinrich, general chairman, Phillips Petroleum Co., Bartlesville, Okla.

Care of Refinery a Topic At Western Conference

A SECTION on maintenance in petroleum processing plants will be included in the discussions of the Western Plant Maintenance and Engineering Conference, to be held in Los Angeles, Calif., on July 13 and 14. Phases of petroleum plant maintenance to be brought up are spare-part and stand-by equipment problems, the procedure of keeping and using maintenance records, planning and scheduling work, protection against corrosion, and unit turn-around practices.

Other sections will be devoted to inspection procedures and frequencies, maintenance of electrical equipment, lubrication and its influence on preventive maintenance, maintenance problems of the small plant, and maintenance procedures in three industries —aircraft, metal-working and food processing.

General sessions of the conference will deal with the principle of maintenance organization and management, planning and scheduling maintenance operations, and, finally, training people for maintenance work.

The conference's general sessions will occupy the morning of July 13, with the afternoon and morning of the following day being used for the sectional conferences.

California Gasoline Assn. Charters New Chapter

CALIFORNIA Natural Gasoline Association has chartered its fourth chapter, to be known as the San Francisco Bay Chapter, to serve as a forum for technical problems arising in that area. Others are located in Ventura, Taft and the Los Angeles Basin.

Warren H. Kraft, Honolulu Oil Corp., and immediate past president of CNGA, is acting as chairman protem during the organization period. Initial meeting of the new chapter was scheduled to be held some time in April.

Oil Man's Calendar

MAY

Scientific Apparatus Makers Association, 36th annual meeting, the Broadmoor, Colorado Springs, Colo., May 2-7.

Air Pollution Control Association, Patten Hotel, Chattanooga, Tenn., May 3-6.

Liquefied Petroleum Gas Association, annual convention, Conrad Hilton Hotel, Chicago, Ill., May 9-12.

American Petroleum Institute, Division of Refining, 19th mid-year meeting, Rice Hotel, Houston, Texas, May 10-13.

American Institute of Chemical Engineers, national meeting, Hotel Kimball, Springfield, Mass., May 16-19.

2nd Basic Materials Exposition and Conference, International Amphitheatre, Chicago, Ill., May 17-20.

JUNE

American Society for Testing Materials, 57th annual meeting and exhibit of testing apparatus, Sherman and Morrison Hotels, Chicago, Ill., June 13-18.

15th Management Course, College of Engineering, State University of Iowa, Iowa City, Ia., June 14-26.

American Institute of Chemical Engineers, meeting on nuclear energy, University of Michigan, Ann Arbor, Mich., June 20-23.

Chemical Institute of Canada, 37th annual conference and exhibition, Toronto, Can., June 21-23.

JULY

1st Western Plant Maintenance Show, Pan Pacific Auditorium, Los Angeles, Calif., July 13-14.

AUGUST

American Institute of Chemical Engineers, annual meeting, New York City, Aug. 12-15.

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

BUBBLE CAPS and risers, Catalog 52, The Pressed Steel Co. See adv't. p. 788.

CATALYST for reforming, brochure "Catforming," Atlantic Refining Co. See adv't. p. 654.

CATALYSTS, preformed, booklet available, Harshaw Chemical Co. See adv't. p. 784.

CATALYST CARRIERS made of "Alundum," Bulletins 7, 140, 793, The Norton Co. See adv't. p. 652-653.

CHEMICALS, aluminum, brochure "Reynolds Aluminum Chemicals," Reynolds Metals Co. See adv't. p. 783.

CONTROLLERS, pressure and level, complete catalog available, Black, Sivalls and Bryson, Inc. See adv't. p. 807.

CONTROLLERS, recording, Bulletin 98151, Taylor Instrument Cos. See adv't. p. 642-643.

COOLING TOWERS, cross-flow, Bulletin CF-54, The Marley Co. See adv't. p. 676.

DETERGENTS, tank cleaning, booklet available, Oakite Products, Inc. See adv't. p. 793.

ELECTRICAL CONDUIT, rigid, aluminum, new booklet, Aluminum Co. of America. See adv't. p. 800.

EXCHANGERS, scraped surface, cooling and heating, Bulletin PE-1, Henry Vogt Machine Co. See adv't. p. 792.

EXPANSION JOINTS, Bulletin 351 describes standard types, Zallea Brothers. See adv't. p. 764.

FABRICATION and design of Natural Gas plants, Bulletin FC-RC-0.004, The Fluor Corp., Ltd. See adv't. p. 624.

FILTERS for high pressure service, Bulletin 31B, Micro Metallic Corp. See adv't. p. 798.

FITTINGS, welding, "Globe Welding Fittings Catalog," Globe Steel Tubes Co. See adv't. p. 640.

GASKETS, teflon, Bulletin TG-953, U. S. Gasket Co. See adv't. p. 750.

GENERATORS, oxygen-nitrogen, 36-page brochure, Air Products, Inc. See adv't. p. 787.

INSTRUMENTS, temperature indicating, Catalog 200G, Palmer Thermometers, Inc. See adv't. p. 760.

INSULATION, industrial, technical bulletins available, Philip Carey Mfg. Co. See adv't. p. 775.

LEAD for corrosion control, booklet "Chemical Lead Products," National Lead Co. See adv't. p. 646.

MIXERS, fixed mounting, Bulletin 610-A, Eastern Industries, Inc. See adv't. p. 671.

MIXERS, side and top entering, Catalogs B-102, B-103, B-104; portable B-108, Mixing Equipment Co. See adv't. p. 680.

NICKEL ALLOYS for process equipment, Technical Bulletin T-5, International Nickel Co. See adv't. p. 804.

OVENS, Freas and Thelco, Catalog No. 331, Precision Scientific Co. See adv't. p. 674.

PUMPS, metering and proportioning, catalog available, Hills-McCanna Co. See adv't. p. 756.

RECORDER, electronic, temperature, and level indicators, six booklets available, Fielden Instrument Div. See adv't. p. 786.

REFRACTORY LININGS, hydraulic-setting, brochure RC-28A on "Blazecrete" and "Firecrete," Johns-Manville Corp. See adv't. p. 635.

STEEL, stainless, for refinery service, booklet on performance available, U. S. Stainless Steel. See adv't. p. 803.

STEEL, "Tulsa-Type" oil refinery equipment, general catalog available, Flint Steel Corp. See adv't. p. 790.

STEAM TRAPS, impulse, Yarway Bulletin T-1740, Yarnall-Waring Co. See adv't. p. 658.

STEAM TRAPS, smaller sized with Duostep leverage, brochure available, Clark Mfg. Co. See adv't. p. 762.

STEAM TRAPS, thermostatic, Catalog 953, W. H. Nicholson and Co. See adv't. p. 633.

THERMOMETERS and Hydrometers, complete catalog, The Emil Greiner Co. See adv't. p. 802.

TRUCKSTER for light hauling, illustrated booklet, Cushman Motor Works, Inc. See adv't. p. 785.

TUBE FITTINGS, Swagelok catalog available, Crawford Fitting Co. See adv't. p. 751.

TUBES, condenser, booklet available, Wolverine Tube Div. See adv't. p. 757.

TUBES, condenser, publication B-2, American Brass Co. See adv't. p. 672A.

TURBINES, mechanical-drive, Bulletin GEA-4955A, General Electric Co. See adv't. p. 648-649.

VALVES, control, Catalog LB-1. Conoflow Corp. See adv't. p. 672.

VALVES, Lever-Seald, Reference Book No. 39-3, Homestead Valve Mfg. Co. See adv't. p. 766.

VALVES, steel, dry-plug, catalogs available, Wedgeplug Valve Co., Inc. See adv't. p. 634.

VALVES, steel gate, catalog available, Crane Co. See adv't. p. 730.

VESSELS, glassed-steel, Bulletin 894-G-5 "Buyer's Guide to Pfaudler Equipment and Services," The Pfaudler Co. See adv't. p. 732.

WATER SEPARATORS for refinery applications, Process Manual R-101-53, Warner Lewis Co. See adv't. p. 772.

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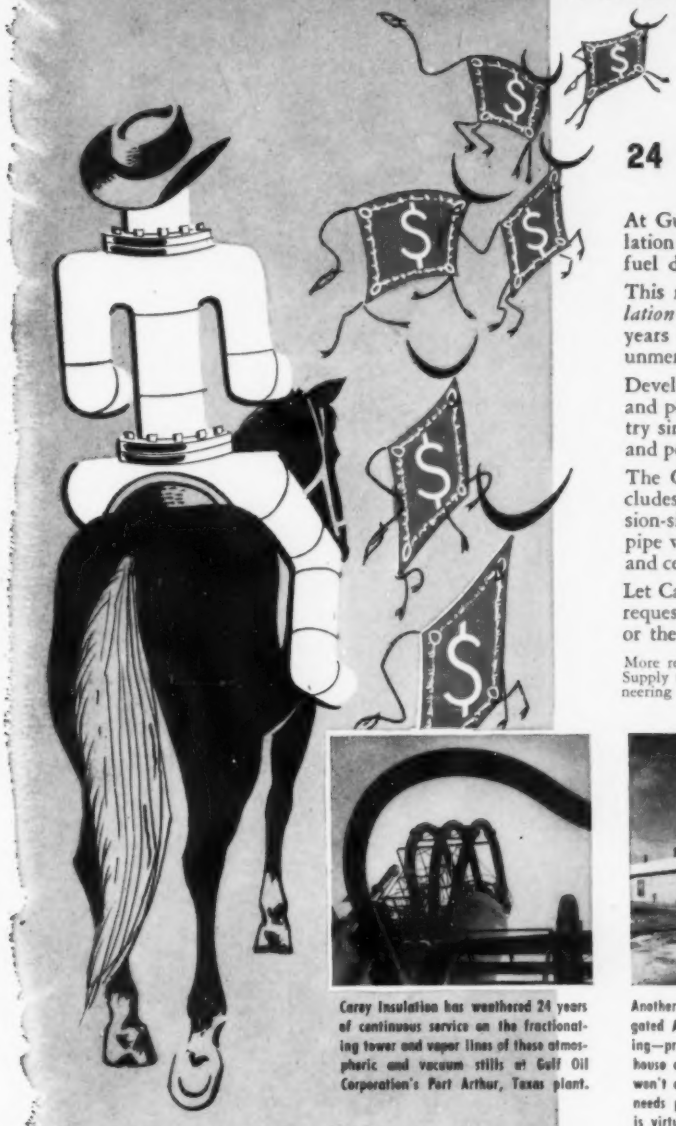

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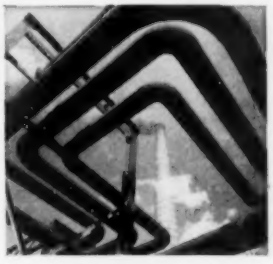

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Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

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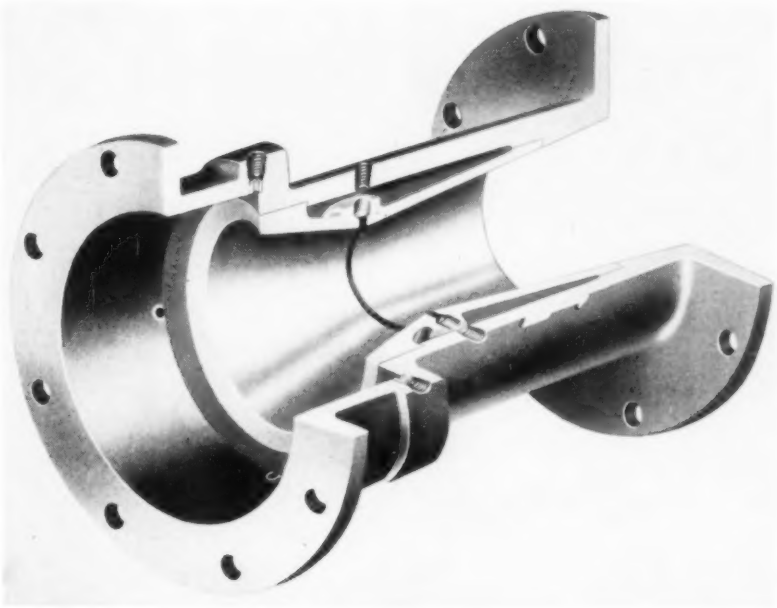
(I-3) U. S. Steel, Oil Well Supply Co. ... 621
(K-7) U. S. Stoneware Co. 758
(K-8) Universal Oil Prods. Co. 656-657
(K-9) Universal Oil Prods. Co. 673
(L-1) Vogt Machine Co., Henry 792
(L-2) Warner Lewis Co. 772
(L-3) Warren Petroleum Corp. 768
(L-4) Wedgeplug Valve Co. 634
(L-5) Western Supply Co. 641
(B-7) Wolverine Tube Div., Calumet & Hecla, Inc. 757
(L-6) Wright Chemical Corp. 789
(L-7) Wyatt Metal & Boiler Works.... Cover 4
(L-8) Yarnall-Waring Co. 658
(L-9) Zallea Brothers 764

WHAT'S NEW . . .



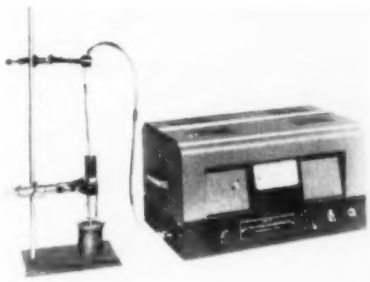
Flow Tube Has Low Head Loss

Designed for use with gases and liquids carrying no settleable solids, the new B-I-F "Dall Flow Tube" consists of a short, flanged, cylindrical body designed with an abrupt decrease in diameter, followed by a conical restriction and diverging outlet. The reduced area at the cone entrance together with the design of the annular throat induces the high differential pressure obtained. The diverging outlet cone provides the high recovery of differential pressure. As a result, the tube is said to have the lowest permanent head loss of any known differential producer of the velocity increasing type. Its short length and low weight make for easy installation. Body is of Meehanite iron: liner of bronze for corrosion resistance. Models are available in capacities from about 160 to 31,000 gpm., and in maximum differential from 20 to 320 in. water. Head losses vary from 2.5 to 9% of differential. B-I-F Industries, Inc., 345 Harris Ave., Providence, R.I.

Circle No. **1** *on Reply Card*

For More Information

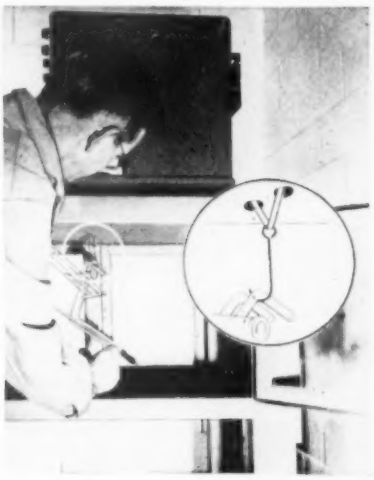
Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage is required.



Ultrasonic Viscosimeter Supplied In Three Different Models

. . . for laboratory use and industrial use. The one shown in the photo, for laboratory use, occupies a minimum of table space. The industrial models may be used in their own steel cabinets or mounted on a standard relay rack. A third type is an explosion and water proof modification of the industrial unit and is enclosed in a cast aluminum housing. Provisions are made for connecting any of them to any standard recorder-controller for continuous process monitoring. The probe, with no moving parts, can be immersed directly in the liquid in a pipe line, a kettle, or a beaker. Viscosities, from 0 to 100,000 centipoises, are read directly. The unit will operate at room or elevated temperatures and under pressure. Ultrasonic Engrg. Co., Box 46, Maywood, Ill.

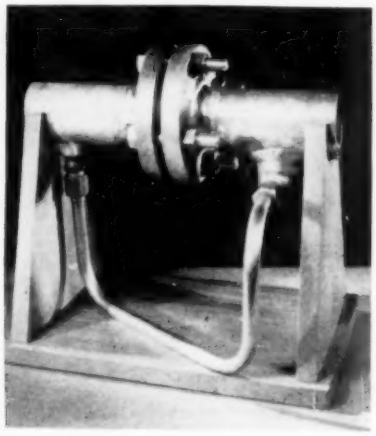
Circle No. **2** *on Reply Card*



Special-Purpose Balance Can Handle Unusual Lab Jobs

. . . such as, for example, that shown in the photograph. Illustration shows it in use at the Gulf research laboratories at Harmarville, Pa. An adsorption tube too large to fit into any balance weighing chamber is being weighed *outside* the balance chamber by means of a stirrup, which runs through holes in the balance floor, and a sample hook. The balance itself is a standard design of the Fisher "Gram-atic," a single-pan, constant-load, constant sensitivity, direct-reading unit in which there is no personal handling of the weights. The new special purpose model has the same accuracy, capacity, and optical range. Other new applications possible include: weighing extremely light materials in odd sizes and shapes; the precise determination of loss-in-weight of samples suspended in a drying oven; and specific-gravity analyses at controlled temperatures. Mildly radioactive samples in a shielded compartment under the balance can also be weighed. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Circle No. **3** *on Reply Card*



Steam Tracer Is Integral with Pipe

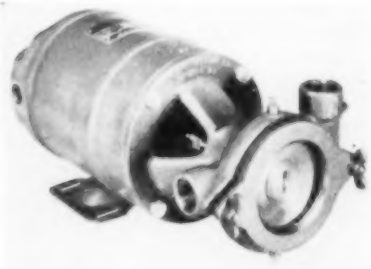
Solving a chemical plant problem in the transfer by pipe of sluggish materials or tricky solutions is a new development by engineers of both Aluminum Co. of America and Hercules Powder Co.

Called "Unitrace," it consists essentially of an integrally extruded steam-traced aluminum pipe. Extruded as a single unit from Alcoa 3S-F aluminum alloy, the new product is slightly oval in cross section because of the crescent-shaped steam passage adjacent to the product line. The size now available has pipe dimensions of 2-in., Schedule 40.

Considerable savings have been found in its original installation over conventional 2-in. steam jacketed lines: amounting to 38¢ per foot on material, 5¢ per foot on insulation, and a 30% reduction in labor costs, according to the manufacturer.

Pre-formed insulation will fit Unitrace if it is wanted. In the case of the 2-in. pipe, insulation for 2½-in. standard pipe will form naturally. The photos above show the pipe in cross section as well as method of joining sections. Steam line at the joint has been welded shut, welding fittings have been installed. An Alcoa "Utilitube" jumper is used to carry steam across the joint. Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.

Circle No. **4** *on Reply Card*



Easy Accessibility Feature of 30 gpm. Stainless Centrifugal

. . . pump developed for wide variety of corrosive chemicals. Built of Carpenter No. 20 stainless steel, the unit will pump against a head up to 24 lbs. and has a maximum suction lift of 20 in. Hg. vacuum. The rear suction and discharge permit accessibility without disconnecting the pump from the line. Fluid being pumped can be seen through the Pyrex front cover plate. Internal parts are reached by removal of just two wing nuts. Continuous suction on the stuffing box reduces the possibility of material being pumped from entering the mechanical seal. A variety of impeller designs are available for handling clear or abrasive fluids. Eco Engineering Co., 12 New York Ave., Newark 1, N. J.

Circle No. **5** *on Reply Card*

New Liquid Flow Meter Uses Electro-magnetic Principle

. . . permitting measurement of a great variety of conductive liquids. Water and aqueous solutions, acids and other corrosive liquids, slurries, emulsions, opaque liquids, and liquids containing solids in suspension can be metered, as well as molten salts and liquid metals. High pressures and temperatures, or a high concentration of suspended matter, present no obstacles. The metering element consists only of an enclosed magnet, stainless steel tube with Teflon liner, and attached electrodes, which are connected to an indicator or recorder remotely installed at any desired location. Nothing can wear out: no clogging can occur. Pressure drop is no more than that for a length of pipe equivalent to the metering element. Limit of accuracy of the new "Xactronic" meter is rated at 1% of full-scale reading, but under appropriate conditions an accuracy of ½% can be obtained. Instrument scale is linear. Six sizes are available, ranging from ½ to 2 in. Capacity is limited only by the pipe size. Bowser, Inc., Ft. Wayne, Ind.

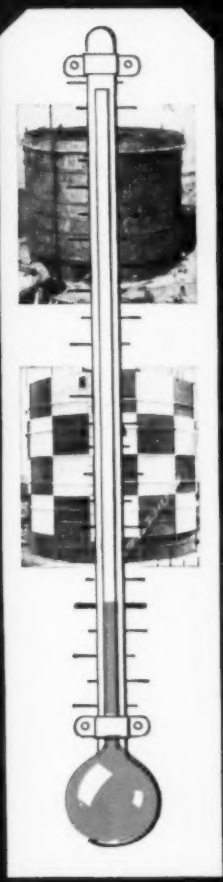
Circle No. **6** *on Reply Card*

Portable Flood Light Approved For All Hazardous Area Uses

. . . and is said to be the only one permitted by Underwriters' Laboratories for use in hydrogen, acetylene, and manufactured gas areas. This was accomplished by using the principle of maintaining an interior air pressure greater than the surrounding atmosphere in the fixture. This prevents the entry of any gas and eliminates all breathing, which normally occurs in such units. Full air and water integrity is maintained until the lamp is changed at the end of 4000 hours, unless the unit is damaged, in which case a micro switch automatically extinguishes the lamp at 3.5 psi. Air and water integrity is maintained by use of a special Formica-engineered plastic that is first molded, and then machined to extremely close tolerances. The Formica Co., Cincinnati 32, Ohio.

Circle No. **7** *on Reply Card*

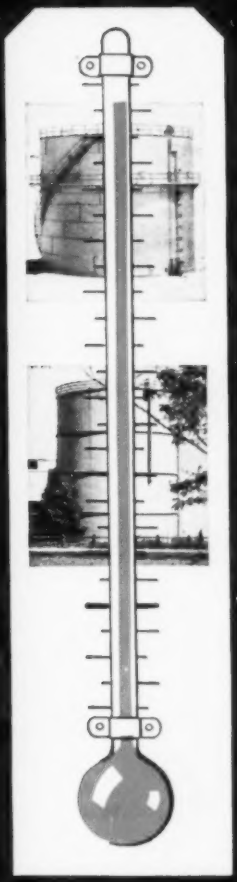
from the **ARCTIC** to the **TROPICS**



more than

130

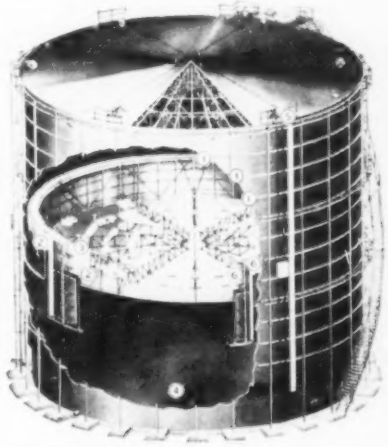
WIGGINS GASHOLDERS have eliminated operating costs for users of chemical process and industrial gases



This 100% dry seal gasholder (no water, no tar, no grease) has proved itself under every condition of climate and temperature. Because of the seal and the simple operating mechanism, operating costs have been entirely eliminated. Comparison of maintenance expense by owners of Wiggins gasholders also shows remarkable savings. Companies who have converted old-type gasholders to the Wiggins advantages have been able to enjoy similar savings. Write for information.

PISTON RISES NEARLY TO TOP—MINIMUM OF WASTE SPACE
CAN BE BUILT ANY SIZE • NO CONTAMINATION OF GAS

1. Space above piston completely ventilated
2. Wide clearances simplify operation.
3. Gas-tight frictionless seal not affected by weather.
4. Piston rests on bottom when empty—less than ½ of 1% dead space for purging.
5. Leveling device—independent of side wall—keeps piston level.
6. Fenders prevent all tension in seal.



Wiggins Gasholder

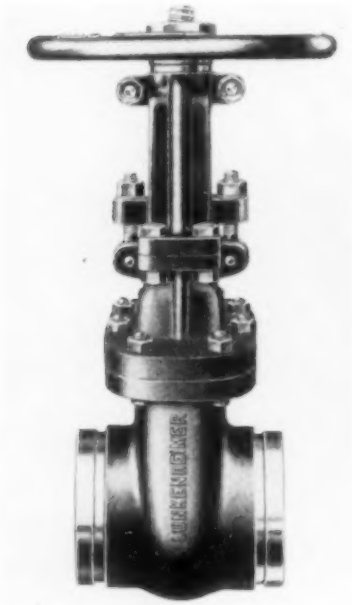
by GENERAL AMERICAN

WIGGINS VAPOR SEALS
GENERAL AMERICAN
TRADE MARK

General American Transportation Corporation
135 SOUTH LA SALLE STREET • CHICAGO 90, ILLINOIS

Offices in Principal Cities

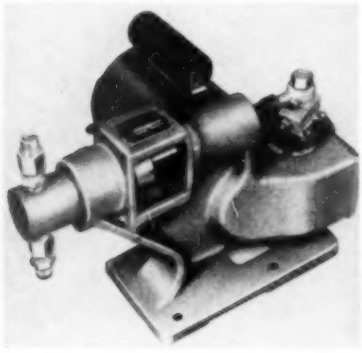
Export Dept.: 380 Madison Avenue, New York 17, N. Y.
Plants: Birmingham Ala. • East Chicago, Ind. • Sharon, Pa.
In Canada: Toronto Iron Works, Ltd., Toronto, Ontario



Grooved-end Gate Valves Cut Labor Costs in Tank Hook-ups

. . . among other jobs, because a simple, two-bolt collar reduces the time normally consumed in conventional pipe fitting. Valves are available in the 225 pound W.O.G. "King-Clip" and 200 pound W.O.G. IronBody Bronze Mounted patterns, and sizes ranging from 2 to 8 in. The new valve design also eliminates the necessity for using grooved-end adapters to connect screw end or flanged end valves in lines where the grooved-end pipe and couplings are already being used. The Lunkenheimer Co., Cincinnati, Ohio.

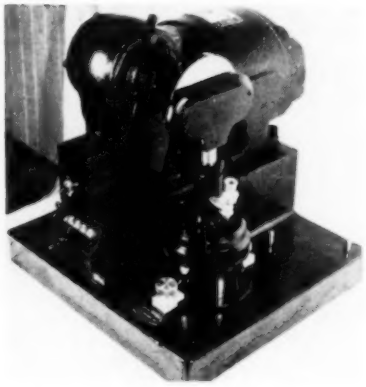
Circle No **8** *on Reply Card*



Proportioning Pump Now Being Offered in Two Capacities

. . . and a variety of voltages with open or explosion-proof motor drives. The Model 11-5-S can be obtained in 10 or 20 gph sizes, and with either standard steel and stainless trim measuring cylinder assemblies, or with measuring cylinder assemblies of 316 stainless steel and with ceramic plungers. New features of the pumps are a self-aligning connecting rod and a one-piece bar stock cylinder. The manufacturer will maintain the pump on a stock basis for quick shipment in four sizes and in various materials of construction with both kinds of motors. Proportioneers, Inc., Providence, R.I.

Circle No. **9** *on Reply Card*



Automatic Grease Worker Has Wide Temperature Range

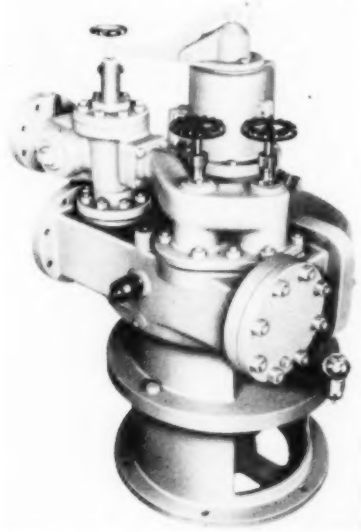
. . . from —65 to 300° F. It is suitable for and meets all requirements of the ASTM D 217 Cone Penetration of Lubricating Greases test, as well as Armed Forces Specifications AN-G-15-a and AN-G-25, and Federal Specification 31.3. In general, it is suitable for all tests and research on the shear stability of liquids and plastic solids under prolonged and reproducable isothermal mechanical working. Drive unit is a ¼-hp. integral motor-speed reducer. A pre-set counter totals strokes of the worker and shuts off the machine at the pre-set number of strokes. Constant temperature is maintained with a thermocouple and jacket for circulating water, controlling and indicating the temperature to ±0.1° F. Technical Equipment Co., 743 Dwight Way, Berkeley 10, Calif.

Circle No. **10** *on Reply Card*

Sheet Aluminum Is Designed For Jacketing Insulated Lines

. . . and equipment, either indoors or outdoors. Called "Al-Cor-Jac," it is corrugated for strength and for expansion and contraction. When used over 85% magnesia, or where wet conditions exist, a vapor-proof barrier is included. For this service, a kraft paper, impregnated and coated with an asphaltic compound is employed. When it is installed, a lap of 1 in. is made at each joint and also along seams. Installation accessories are optional. Any of the following may be used: staples; tapes (aluminum foil); bands (aluminum straps), and screws (aluminum straps and self-tapping screws). Jacketing is available in two forms: with and without vapor barrier. The former comes in 100-ft. rolls, 48 in. wide. Roll weight is approximately 40 lb. Latter is in 200-ft. rolls, 48 in. wide, and roll weight is 50 lb. Aljon Mfg. Co., Inc., Chestnut St. and Highland Parkway, Roselle, N.J.

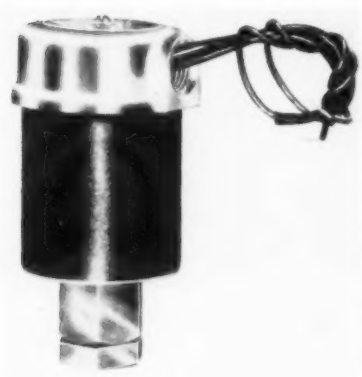
Circle No. **11** *on Reply Card*



Added Steam Nozzle Boosts Power of Vertical Turbines

. . . in all models in the manufacturer's line. The Model DH-10V (new in the vertical line) and the DH-20V have 100% more power than the former single-nozzle counterparts. The Model DH-30V has three instead of two nozzles, and has gained 50% power. Two hand valves help regulate water rate at reduced loads. Improved packing boxes check steam pressure leakage and permit higher working exhaust steam pressure. Ball bearings are double-row with greater thrust capacity. Overlapping labyrinth slinger on the lower bearing prevents moisture seepage. An improved emergency trip mechanism has a cylindrical guides to maintain alignment of trip valve stem in all positions. Dean Hill Pump Co., Dept. 1, Indianapolis 7, Ind.

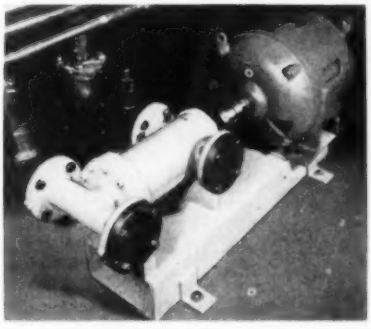
Circle No. **12** *on Reply Card*



Stainless, Solenoid Direct Lift Valve Designed for 5000 psi.

. . . to 150° F. maximum, and 2500 psi. to 400° F. maximum. Available in 1/8 and ¼-in. pipe sizes, the orifice sizes range from 1/16 to 3/16 in. diameter, depending upon pressure requirements and the coil used. Valve bodies are of 303 stainless steel; solenoid armature is Type 416. Paper wound or glass impregnated coils are used, depending upon the temperature range. For use on temperatures in excess of 180° F., glass wound, silicone impregnated coils are recommended. Coils used on normal pressure ranges are single wound. Higher pressures use double wound coils with two separate windings: an extremely strong primary winding for initial pull-off and a normal winding for holding the armatures in the coil field during operation. Atkomatic Valve Co., Dept. B238, 545 West Abbott St., Indianapolis, Ind.

Circle No. **13** *on Reply Card*



New Colloidal Mill Design Needs No Cooling Apparatus

. . . Because of the negligible amount of heated generated. The "Cazenovia Disc Disperser" uses knives which provide positive shearing action on the material instead of the usual tearing that generates large amounts

INCREASE PRODUCTION
CUT OPERATING COSTS

with the AIRETOOL "BIG THREE"

A well-rounded tube maintenance program employing the regular use of Airetool Tube Cleaners and Tube Expanders, plus the Airetool Tube Expansion Control System, will keep any plant at peak efficiency and economy, and eliminate costly downtime due to tube failure. Powerful, high-speed cleaners quickly remove even the hardest deposits from straight or curved tubes. Tube joints are rolled tightly and accurately with maximum bond when Airetool Tube Expanders are used, while the unique Airetool Tube Expansion Control System cuts, in half, the time needed to overhaul or retube a bundle.

Airetool Cleaner Heads, precision made from special heat treated alloy steel, quickly and thoroughly remove any type of foreign deposit from tubes. The P-type head shown is only one of many Cleaner Head types available.

Airetool Tube Expanders are made from the best alloy steel; correctly designed, precisely machined, and heat treated for enduring service. Parallel rolling and self-feeding, they will produce uniform expansion and tightness throughout the full thickness of the tube sheet.

The Airetool Automatic Tube Expansion Control provides uniformly tight joints, with no over or under expansion . . . giving increased tube end life, and eliminating fracture or distortion of tube sheet ligaments. Tube bundles may be rolled to pre-determined maximum tightness at production line speed — precision electrical control automatically shuts off power at point of maximum bond.

Write for full details about Airetool Tube Cleaners . . . Tube Expanders . . . Automatic Tube Expansion Control Systems.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge.

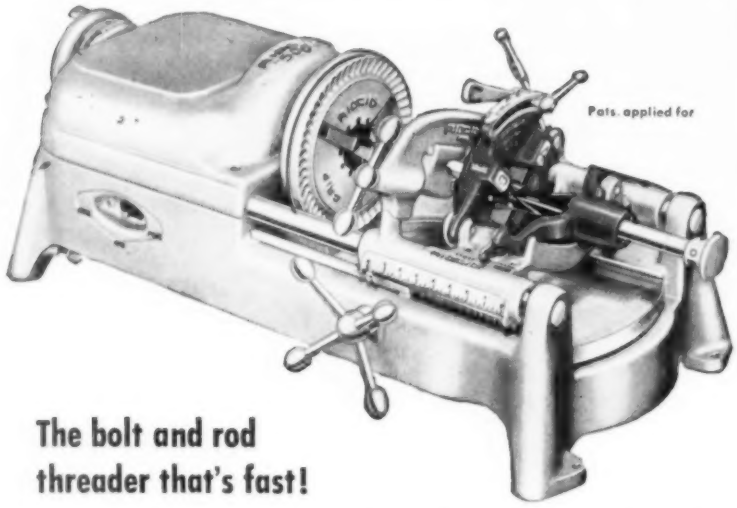
Representatives in Principal Cities of U.S.A., Canada, Mexico, South America and England.

THERE'S AN AIRETOOL TUBE EXPANDER OR TUBE CLEANER FOR EVERY TYPE OF TUBULAR CONSTRUCTION.

(To obtain more data on advertised products see page 776)

For Fast Bolt Threading ... it's the New 500A RIDGID with new "SPEED-GRIP" CHUCK

New principle ... not just another hammer chuck!



The bolt and rod threader that's fast!

Capacity ¼" to 2" bolts — pipe, too, ⅛" to 2"

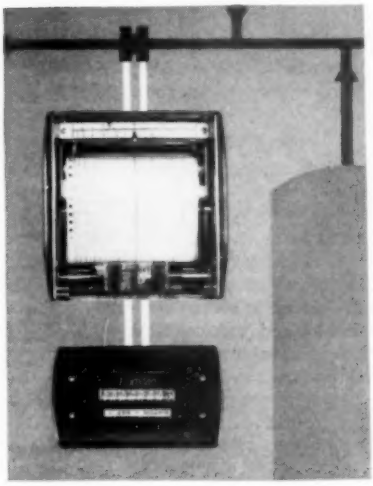
You've got to see it and try it to believe it! Only 2 quick-opening die heads—small head for ¼" to 1" bolts, large head for 1¼" to 2" NC, to 1½" NF—to 2½" in 8N, 12N and 16N . . . easy die change, right or left hand threads, easy adjustment to over or under size. Special dies on request. This 500A threads any length bar to 2½" diam., makes studs with RIDGID Nipple Chuck, cuts off 5/16" to 1" rod. Independent operation of tools. Lots of power. New Speed-Grip Chuck guaranteed to hold rod or pipe securely *forward* or *reverse*—motor action makes it tighter. See it, buy it at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U.S.A.

RIDGID
Work-Saver Pipe Tools

of frictional heat. The knives revolve at a very high rate of speed between perforated plates, and are driven by a 15 hp., 1800 rpm. motor. Overall size of the machine is 53 in. long, 13 in. wide, and 21 in. high. In the case of greases, the disperser cuts the long fibers and stabilizes the grease without over-working, which eliminates the possibility that the grease might return to its original state. Cazenovia Precision Machine Co., East Aurora, N.Y.

Circle No. **14** *on Reply Card*



New Receiver-Integrator Built For Use on Graphic Panels

. . . will compute an accurate and continuous total of any process flow. A pneumatic-electric instrument, the Type 224 operates a small counter located on the graphic board. The integrator comprises two small, self-contained units: a remote counter and a flow receiver. The counter can be mounted on the panel front, usually in conjunction with a "Consotrol" strip-chart flow recorder. It totalizes to eight digits (or six with zero reset wheel) yet occupies only 3¼ x 5½ in of space. The flow receiver unit, composed of a receiver bellows and cam-switch assembly, is housed in a small metal box behind the panel. Two wires connect it to the counter. In use, air signals of the measurement received by the bellows which then positions the cam-switch mechanism. This, in turn, produces an electric impulse to actuate the counter in constant and precise relation to the flow measurement. Integrators are available for uniform or square root scales to totalize minute, hourly, or daily rates. The Foxboro Co., Foxboro, Mass.

Circle No. **15** *on Reply Card*

REYNOLDS ACTIVATED ALUMINA

...Ideal Desiccant for HF Alkylation

more economical and effective for drying many liquids and gases

The specific advantages of Reynolds Activated Alumina for hydrogen fluoride alkylation are:

- **Elimination of silica migration**
- **Better fluoride removal**
- **Dries alkylate while in process**

Basic product advantages include:

- **Non-reactive with process liquids and gases**
- **Easily regenerated**
- **Low initial cost**
- **Withstands liquid water**
- **Low dewpoint**

Prove these advantages in your drying process. Performance will let you compare the absorptive capacity of Reynolds Activated Alumina against the capacity of other desiccants. Write for free brochure on "*Reynolds Aluminum Chemicals*" to Reynolds Metals Company, 2596 South Third Street, Louisville 1, Kentucky.

Put Reynolds Consulting Service To Work For You

The staff of each Reynolds regional office includes chemical and other engineering specialists to help you save time, money and labor with aluminum chemicals, shipping containers and mill products. When further consultation is desired, there is a fully integrated technical staff at Reynolds headquarters.

See "Mister Peepers" Sundays on NBC-TV. Consult local listings for time and station.

REYNOLDS CHEMICALS

FROM THE PRODUCERS OF REYNOLDS ALUMINUM

HARSHAW preformed CATALYSTS

specified by YOU...made by US!

Harshaw manufactures to specification dozens of catalysts for many different and complex manufacturing processes. The experience of more than fifteen years in helping to solve a great number of individual catalyst problems places us in a most helpful position, either in the development of the best and most economical catalyst, or in qualifying with large production capacity requirements. If you have a problem, perhaps a discussion with us will prove helpful.

SEND FOR *this 8-page booklet on Harshaw Catalysts*

PROCESS

Hydroforming	Cyclization	Oxidation
Dehydrogenation	Dehydration	Desulphurization
Alkylation	Isomerization	Hydrogenation

TYPICAL CATALYSTS

Aluminum Chloride Anhydrous — Boron Fluoride Addition Compounds
Boron Trifluoride — Hydrofluoric Acid Anhydrous

Alumina — Chrome Alumina — Molybdena Alumina — Tungsten Alumina
Cobalt — Copper — Magnesia — Mercury — Nickel — Vanadium

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
BRANCHES IN PRINCIPAL CITIES

SALES BRANCHES: Chicago 10, Illinois, 505 North LaSalle St. • Cincinnati 13, Ohio, 6265 Wiehe Rd. • Detroit 28, Michigan, 9240 Hubbell Ave. Houston 11, Texas, 6622 Supply Row • Los Angeles 22, California, 3237 S. Garfield Ave. • New York 17, N. Y., 420 Lexington Ave. Philadelphia 48, Pennsylvania, Jackson & Swanson Sts. • Pittsburgh 22, Pennsylvania, 505 Bessemer Bldg., 6th & Duquesne Way

 (To obtain more data on advertised products see page 776)

Protection Against Toxic Liquids Built Into New Safety Pipette

. . . control. Tradenamed the "Micropet," the unit eliminates mouth pipetting and prevents accidental imbibing of either toxic or infectious materials. In use, the pipette is slipped into the opening provided in the Micropet. Fluid is drawn in by collapsing and releasing the rubber bulb. Fluid is dispensed by depressing a release plunger. A delayed action mechanism in the plunger permits the technician to control the discharge from a rapid to a barely perceptible flow. Aliquots may be dispensed with an accuracy of 0.01 ml. The unit is fabricated of anodized aluminum and other corrosion resistant materials. Exterior is knurled for non-slippage. Entire Micropet weighs only 2¾ oz. National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.

Circle No. **16** *on Reply Card*

Two New Rod Packings Have High Resistance to Solvents

. . . such as benzene, carbon tetrachloride, xylene, turpentine, kerosene, gasoline, and Stoddards solvents. They utilize a newly developed lubricant and impregnation process for handling such non-water-soluble substances. Style No. 181 has a square braided rayon base, and is recommended for pumps, valves, and fittings handling

DURAMETALLIC Packings
VALVES
CENTRIFUGAL PUMPS
Throughout your plant
. . . wherever you have stuffing boxes to be repacked, specify Durametallic "Engineered For The Job" products for longer packing life and satisfactory sealing service.
Write today for our packing File No. DMPP
DURAMETALLIC CORP.
KALAMAZOO, MICHIGAN
COMPRESSORS
RECIPROCATING PUMPS

NOW! SHAFT DRIVE POWER in LIGHT hauling!
TOTAL OPERATING COST ¾¢ PER MILE
• EXTRA POWER
• EXTRA CAPACITY
• EXTRA ECONOMY
Slash inner plant handling and delivery costs as have hundreds of other plants. Put Cushman 780 TRUCKSTERS on your jobs—NEW this year with SHAFT DRIVE. Complete with 3 speeds forward, one reverse. Get the EXTRA power advantages of big vehicle shaft drive—plus quick, easy handling AND low operating cost—less than a penny a mile. With capacity up to 500 pounds, TRUCKSTER can speed up hundreds of handling jobs for you!
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• See Your Nearest Cushman Dealer for FREE demonstration
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780
SHAFT DRIVE
TRUCKSTER
SOLD and SERVICED NATIONALLY
CUSHMAN MOTOR WORKS, INC.
964 No. 21st St.
Lincoln, Nebraska

(To obtain more data on advertised products see page 776)

can you really buy high accuracy at low cost?

of course you can! This new Fielden Resistance Thermometer Recorder, for instance, measures temperatures up to 950°F. with an inherent accuracy of ±0.5% of full scale! But it sets a new price standard because . . .

. . . we've eliminated the usual design complexities. For example, this self-balancing type recorder uses an AC-actuated bridge circuit that eliminates direct current source and replacement of dry cells. An interchangeable measuring unit permits change in range or measurement without re-wiring. The complete recorder is assembled from only 5 easily replaceable and interchangeable sub-units.

This is Fielden simplified instrumentation—all the accuracy you can possibly use—at an economical price. Mail the coupon for full details.

DOLLAR FOR DOLLAR—YOUR BEST INSTRUMENT VALUE

Robertshaw-Fulton
CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
2920 N. 4th St., Dept. K, Philadelphia 33, Pa.

Send full details on Fielden simplified:

- ☐ TEKTOLOG Electronic Recorder
- ☐ TELSTOR Electronic Level Indicator
- ☐ TEKTOR Electronic Level Control
- ☐ Resistance Thermometer Recorder
- ☐ MULTIPOINT Recorders
- ☐ Series 97 Temperature Controls

*Name*_____
*Title*_____
*Company*_____
*Address*_____ *City*_____ *State*_____

such materials at temperatures up to 200° F. Style No. 1024 is recommended for temperatures above 200° F. It has a braid-over-braid, white asbestos base. Flexrock Co. Packing Division, 3602-T Filbert St., Philadelphia 1, Penna.

Circle No. **17** *on Reply Card*

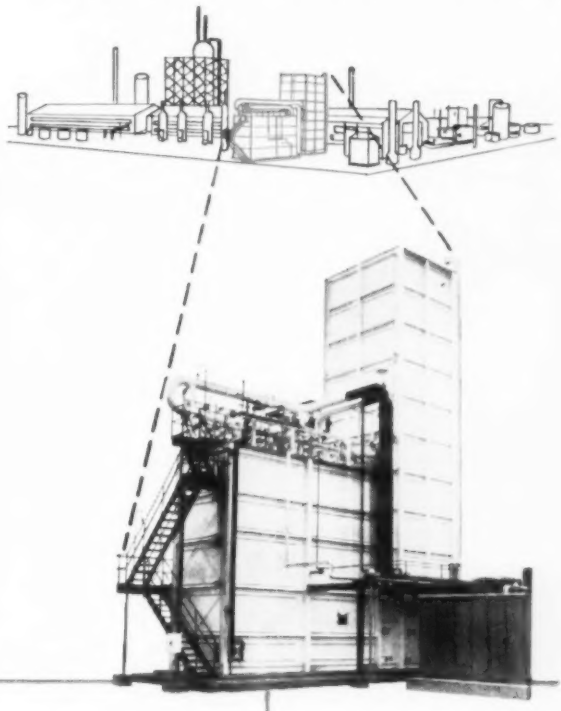
New Pressure Monitor Designed To Give Calibrated Readings

. . . of any dynamic pressure. Designated the "5AC" Pressure Monitor, the device can be used with any two or four arm strain gage transducer and standard oscilloscope. It is designed specifically, however, for use with the manufacturer's Model EP pressure pickup. If the sensitivity of the transducer being used is known in terms of microvolts per volt per psi., the pressure monitor calibration system can be utilized to indicate pressures in psi. without recourse to any other calibration procedure. The type of calibration circuit used allows static as well as rapidly fluctuating pressures to be measured accurately. The calibration circuit provides a reference pip at any point throughout the range of the instrument and compensates for non-linearities in all subsequent circuitry. This pulse can be generated at any time without returning to zero pressure on the pickup. A second position of the calibration circuit switch generates a zero pressure pulse to indicate drift or the presence of static pressure. The monitor may be set to read in % of full scale of transducer output or in psi. Control Engineering Corp., Norwood, Mass.

Circle No. **18** *on Reply Card*

Tonnage Oxygen-Nitrogen Generators

Entrust this important portion of your new process plant to *Air Products* INCORPORATED



Best Cycle for Your Requirements

High or low pressure cycle, according to your particular needs. *Air Products* is experienced with both for unbiased appraisal.

Engineering Staff Always Available

. . . through planning, process design, fabrication, erection, start-up, and on through the years of operation.

Integrated Engineering-Manufacturing Service

Engineering staff at the scene of manufacture. Allows best transposition of engineering skill into completed apparatus.

Specialists in Low-Temperature Processing

Air Products has designed and built over 600 low-temperature plants for gas separation. Trouble-free progress from planning to start-up.

Modern Production Equipment and Methods

Small parts made on mass production equipment . . . sub-assemblies made on assembly lines. Moving parts are interchangeable.

Service Points throughout the U.S.

Air Products' skilled erection-service engineers and technicians . . . plus stocks of spare parts . . . are located at strategic points in the U.S.

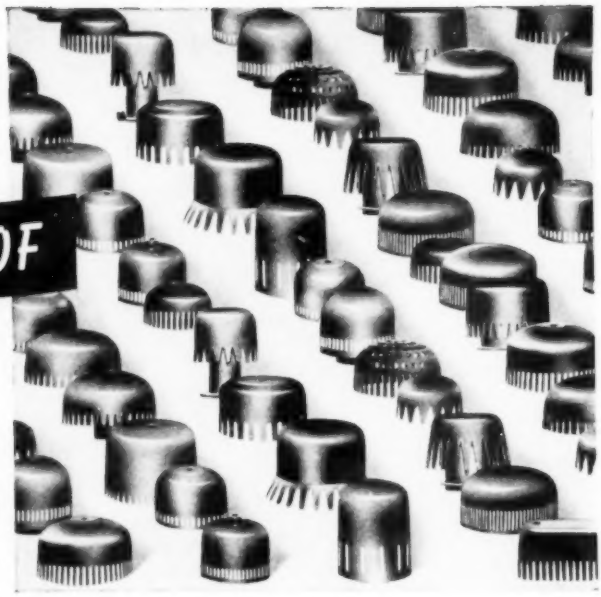
Your requirements for oxygen and/or nitrogen . . . whatever purities, capacities, pressures you need . . . can be obtained at lowest final cost with an *Air Products* Tonnage Generator. *Air Products* does the complete job maintaining close cooperation with you. Progress is smooth, fast. You get the best possible design and most dependable equipment. You save engineering time . . . maintenance costs . . . costly down-time. Talk it over with us! *Air Products Incorporated, Dept. L, Box 538, Allentown, Pa.*

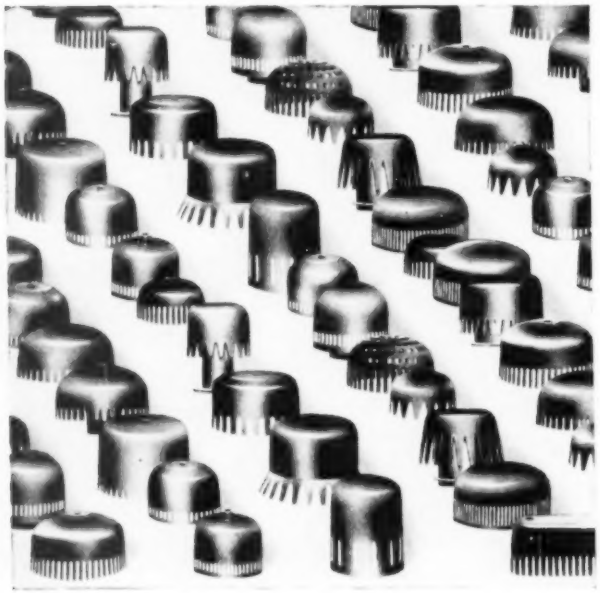
Also Standard High-Purity Oxygen-Nitrogen Generators . . . "Package" and Larger Capacity Hydrogen Purification Plants . . . other Low-Temperature Processing Plants for Gas Separation. Write on company letterhead for 36-page Brochure.

Air Products INCORPORATED

Specialists in Low-Temperature Processing

300 STANDARD STYLES OF PSC Bubble Caps & Risers





...promptly furnished *WITHOUT DIE COST*

With dies on hand for over 300 standard styles of bubble caps and risers, PSC is in a position not only to save many customers the cost of dies but also to save them design and delivery time. PSC bubble caps are also effecting substantial maintenance economies, due to the fact that PSC customers can order bubble caps in the particular metal which best meets their specific heat and corrosion requirements. We fabricate caps from any metal: aluminum, brass, copper, nickel, stainless steel in any chrome-nickel or straight chrome type, as well as carbon steel.

You'll Be Days and Dollars Ahead with PSC Caps

PSC catalog 52 contains, we believe, the largest compilation of engineering data on bubble caps; also drawings for use in determining methods of tray assembly. Details in catalog can be modified in almost unlimited ways to suit your needs. Special caps made to order.

—SEND FOR CATALOG 52→

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

(To obtain more data on advertised products see page 776)

Precise Titrations Are Possible With Needle Valve Burette

. . . replacing conventional stopcock. With the new device, the manufacturer states a laboratory technician can work faster, more accurately, and eliminate stopcock grease contamination. The valve is constructed of glass and plastic: the liquid comes into contact with only glass and Teflon. Other plastic parts, not in contact with the liquid, are made of "Hysol," said to be resistant to acids, alkalis, salt, and nearly all organic liquids. Emil Greiner Co., 20-26 N. Moore St., New York 13, N.Y.

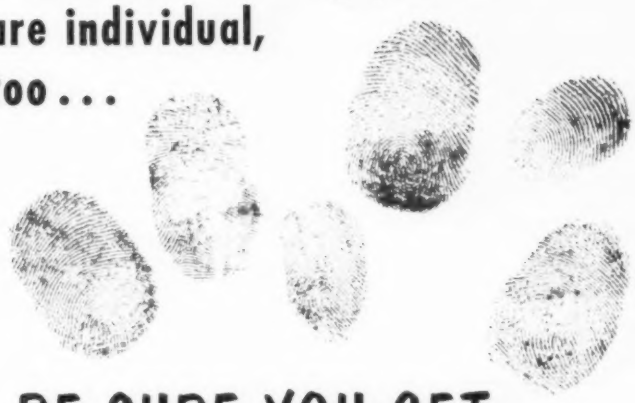
Circle No. **19** *on Reply Card*

Trade Literature

How to Reduce Evaporation

. . . *Losses in the Storage of Petroleum Liquids* is the title of a new, 56-page, thumb-indexed, illustrated manual on this entire subject. It discusses fittings for cone roofs, and design of floating roofs, pan roofs, lifter roofs, and gas-holders; provides nomographs for calculating true vapor pressure, breathing and filling losses in cone roof tanks, standing storage loss in floating roof tanks, liquid surface and vapor space temperature changes, and percentage expansion of air-vapor mixtures. A final section of technical data includes conversion tables, volume tables, API welded tank data, mean temperature change table, snow load map of the United States, and an extensive bibliography. Manual WP-14 has been made in looseleaf style to permit keeping it up to date as new information becomes available. Ad-

Water conditioning problems are individual, too . . .



BE SURE YOU GET THE WRIGHT ANSWER

While each water conditioning problem is different, they all have one thing in common: if not solved properly they can be costly in terms of maintenance time and production losses.

With the Wright Water Conditioning Service, your water conditioning is treated as an individual problem from start to finish. Without obligation on your part, Wright will make a scientific laboratory analysis of your problem, then submit a written proposal for its solution. After you adopt our recommendation, Wright will maintain a constant field and laboratory check to insure proper performance.

So be sure you get the Wright answer. Write, wire or call today.

Wright CHEMICALS

WRIGHT CHEMICAL CORPORATION

GENERAL OFFICES AND LABORATORY
635 WEST LAKE STREET, CHICAGO 6, ILLINOIS
Offices in Principal Cities

- Softeners, Filters and other external Treating Equipment
- Nelson Chemical Proportioning Pumps

ONE BILLION DOLLARS EVERY FIVE YEARS!!

This amount will be spent for petrochemical plant expansion. The 3rd ANNUAL PETROLEUM PROCESSING PETROCHEMICAL MARKETS Issue is designed to help you get your share of this business. PETROLEUM PROCESSING is the BEST medium for reaching *all* classes of refinery buying influences—Management, Engineers and Foremen. Contact your nearest PETROLEUM PROCESSING representative, listed on page 625, for further information about this special issue. Or write direct to:

PETROLEUM PROCESSING
A McGraw-Hill Publication
330 W. 42nd Street **New York 36, N. Y.**

(To obtain more data on advertised products see page 776)

dress requests on company letterhead to General American Transportation Corp., 135 So. La Salle St., Chicago 90, Ill.

Do Not Use Reply Card

Controlled Volume Pump

. . . with diaphragm "Pulsafeeder"; uses hydraulic piston drive, no stuffing box; *Bulletin* 440 contains construction details, capacities, sizes and specifications of all models. Lapp Insulator Co., Le Roy, N. Y.

Circle No. **20** *on Reply Card*

Valves for Instrument Lines

. . . and general use; *Data Unit* 234 contains specifications, special features, illustrations, and information about applications. Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.

Circle No. **21** *on Reply Card*

TULSA TYPE

OIL REFINERY EQUIPMENT
Natural Gasoline Plant Equipment
Chemical Processing Equipment

•

Tulsa Type Equipment is designed and fabricated to meet your specified operating conditions.
Write for general catalog

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

Motor Comparison Chart

. . . for new NEMA a-c. frame assignments; on single page, "Compar-A-Frame" compares dimensions of open type and fan-cooled type of polyphase induction motor; sub-charts on page compare frame sizes according to horsepower and speed, and dimensions of old and new frames. Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio.

Circle No. **22** *on Reply Card*

Wire Mesh Demisters

. . . and their value for increasing the quality of the overhead product and eliminating overhead losses, while permitting operation at high vapor velocities; "Performance of Wire Mesh Demisters," presents case histories from the chemical, petroleum and petrochemical industries. Otto H. York Co., 69 Glenwood Place, East Orange, N. J.

Circle No. **23** *on Reply Card*

Instruments Catalog

. . . of a full line of electric meters, electric and electronic test equipment and controls; *Catalog* 54 has full details, ordering information; 189 pages. Electro-Tech Equipment Co., 308 Canal St., New York 13, N. Y.

Circle No. **24** *on Reply Card*

Liquid Level Gage

. . . attached to graduated tape, fixed at liquid level by spring so it can be read when tape is withdrawn from storage tank; 1-page leaflet describes, illustrates operation. Bico, Inc., 3116 Valhalla Dr., Burbank, Calif.

Circle No. **25** *on Reply Card*

Heat Exchangers

. . . of concentric tube type or tube bundle which can be grouped in series, parallel or combinations; *Bulletin No.* 600-2 has construction details, general information. Industrial Filter & Pump Mfg. Co., Chicago 50, Ill.

Circle No. **26** *on Reply Card*

Vessel Rupture Disc

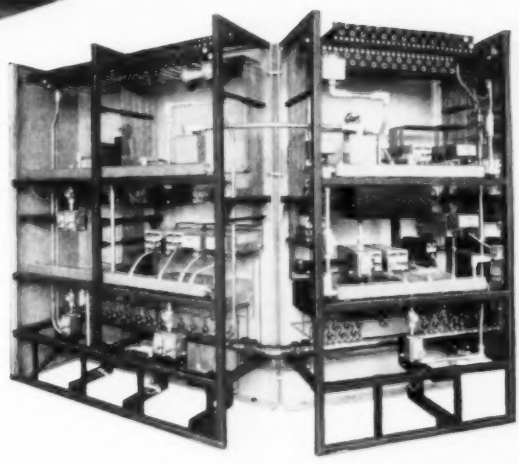
. . . for low pressure and highly corrosive applications; *Catalog* 77-30 gives structural details and performance data for each size disc. Black, Sivalls & Bryson, Inc., 7500 E. 12th St., Kansas City 3, Mo.

Circle No. **27** *on Reply Card*

Creative Contributions
to Centralized
Process Control . . .

GRAPHIC PANELS

by FOXBORO



Typical back-of-panel view. Note open framework construction (easily enclosed if desired), terminals tagged for quick identification in field, neat arrangement of tubing and wiring, full accessibility to all instruments.

Years of experience in panel design and construction have equipped Foxboro Panel Engineers with many exclusive techniques . . . methods which bring you unequalled performance in centralized process control.

One typical feature is the use of aluminum strips and shapes, three-dimensional in effect, in bright, permanent colors, to symbolize flow lines and vessels. These are securely attached over the background finish, yet may readily be rearranged when necessary without marring the finish or leaving ugly holes. (If you prefer, painted graphic panels can be furnished.)

Behind the panel, Foxboro's open framework construction and the neat, clean arrangement of piping and wiring permit quick installation and far easier maintenance.

Foxboro's skilled Panel Assembly Department completes the team which provides you with the most efficient and usable Graphic Panels available today. Let us work up a detailed proposal for you.

The Foxboro Company,
915 Neponset Ave.,
Foxboro, Mass.

FOXBORO
Reg. U. S. Pat. Off.

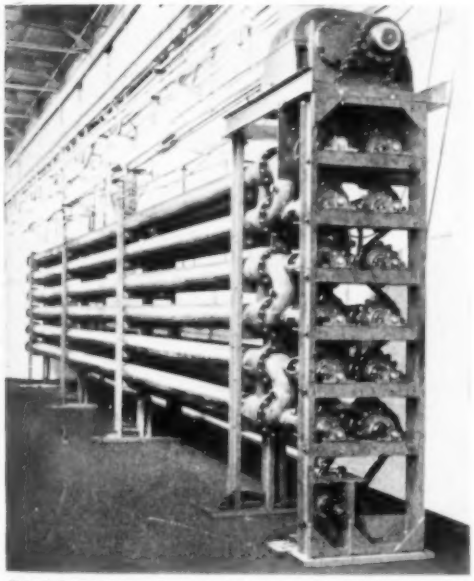
PROCESS CONTROL ENGINEERING

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

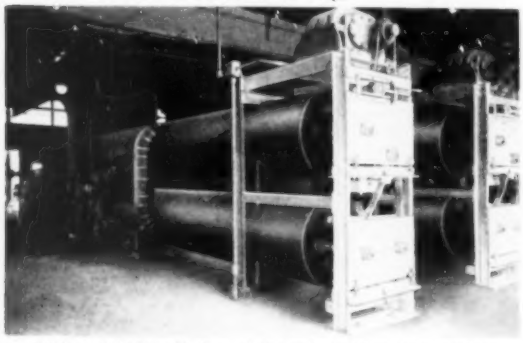
Keep Heat Transfer Surfaces CLEAN...

SPECIFY Vogt

SCRAPED SURFACE *Exchangers*



*DOUBLE PIPE UNIT. Drive end close-up of 12 section unit under test in our shop.



*SHELL and PIPE UNITS. Two of five units installed in a leading petroleum refinery.

*Patented

IF you are all "gummed up" with a tough heat transfer problem, Vogt Scraped Surface Exchangers will provide the answer. They have patented scraper elements which prevent fouling of the heat transfer surfaces and insure the highest rate of heat exchange between the product and the cooling or heating medium. The scrapers also continuously agitate the fluid and assist removal of solids from the unit.

DOUBLE PIPE EQUIPMENT is available in two types; EXCHANGERS, for cooling with water, brine, and cold filtrate, and for heating with steam or hot liquids; and CHILLERS, for use with volatile refrigerants such as ammonia, propane, and Freon. Both types have 8" jacket pipes and 6" inner pipes with scrapers.

SHELL AND PIPE TYPE UNITS are designed for use with volatile refrigerants and for heating fluids with steam or similar heating mediums. They consist of large welded shells each containing seven 6" scraped pipe sections.

Vogt Scraped Surface Exchangers serve profitably as oil chillers, crystallizers, and heaters in many processes in the petroleum and chemical industries. Their application to your heat transfer problems will receive the prompt attention of our Engineering staff.

Write for Bulletin PE-1

HENRY VOGT MACHINE CO

LOUISVILLE 10, KENTUCKY

Branch Offices:

NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO

ST. LOUIS • DALLAS • CHARLESTON, W. VA.

Temperature Control

. . . by regulators having single pilot, combining both a pressure and thermal element; Bulletin, *Form No.* 1008, has cut-away diagram of regulator, operating details and recommended set-ups for water heaters and forced air heating systems. Spence Engineering Co., Walden, N. Y.

Circle No. **28** *on Reply Card*

Centrifugal Extractor

. . . of countercurrent design, for systems using two immiscible liquids; *Bulletin* 102 has description and illustration of model's operation and specifications. Sharples Corp. Research Laboratories, 424 W. 4th St., Bridgeport, Pa.

Circle No. **29** *on Reply Card*

Pump Sequence Control System

. . . for automatically adjusting the number of pumps operating in a multiple installation to fluctuating demand, thus increasing operating efficiency; *Catalog* 91-106 describes elements used in the system and how it works. Fischer & Porter Co., 46 Jacksonville Rd., Hatboro, Pa.

Circle No. **30** *on Reply Card*

Oil Diffusion Pumps

. . . high vacuum, fractionating, diameters from 2 to 32 in., with peak speeds from 60 to 19,000 liters a second; *Data Sheet* 6-55 contains complete physical dimensions, operating data and performance curves for each type. Consolidated Vacuum Corp., Rochester 3, N. Y.

Circle No. **31** *on Reply Card*

Thermocouples & Packing Glands

. . . and protection tubes, bare-wire, with Neoprene, Teflon or powdered talc sealants; *Catalog* 1530 has full line of company's products, plus prices and full specs. Conax Corp., 4515 Main St., Buffalo 21, N. Y.

Circle No. **32** *on Reply Card*

Welded Storage Tanks

. . . including both shop and field welded stock tanks, flow tanks and a line of accessories and venting equipment; *Catalog* 11 contains specifications and construction details for each model of tank. Black, Sivalls & Bryson, Inc., 7500 E. 12th St., Kansas City 3, Mo.

Circle No. **33** *on Reply Card*

Industrial Instruments

. . . including accelerometers, transformers, transducers and recording systems; folder illustrates each type and describes operation. Schaevitz Engineering, Box 505, Camden 1, N. J.

Circle No. **34** *on Reply Card*

Corrosion-Resistant Coating

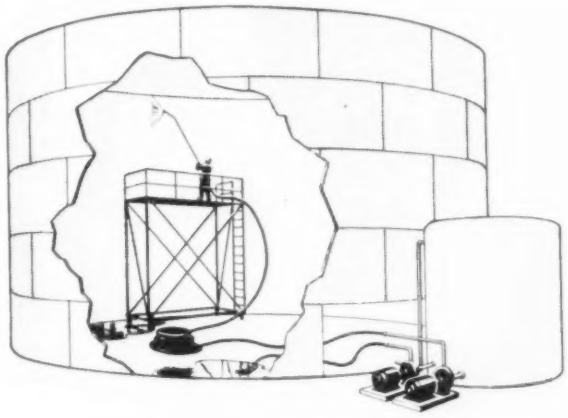
. . . consisting of pulverized aluminum in a plastic base, "Kolmetal"; four-page bulletin describes properties and typical applications. Emjay Maintenance Engineers, 327 Union Ave., Rutherford, N. J.

Circle No. **35** *on Reply Card*

Alloy Reference Chart

. . . listing the chemical analyses, physical properties and recommended applications for 28 different grades of cast stainless steel. Cooper Alloy Foundry Co., Hillside, N. J.

Circle No. **36** *on Reply Card*



Here's a simple plan for low-cost storage tank cleaning

Simple to set up, yet completely effective, this mechanical tank-cleaning method reduces manual cleaning time and cost by more than 75%—provides a clean tank in less than a day. Here's how:

In the drawing above you see all the equipment necessary . . . solution tank, pump, hose, scaffolding . . . all standard equipment, some of it idle scrap. Cold solution of an Oakite Solvent Detergent is pumped through and sprayed over the entire tank surface. Carbonaceous soils quickly loosen . . . are blasted off with high pressure water rinse. Tank is clean, ready for a change of service.

Oakite cleaning makes the big difference! In an Oakite Solvent, you get a soil-chasing compound that helps keep costs down because it's buffered for heavy duty . . . extra speed. Oakite Solvent Detergents quickly break the bond between soil and surface, permitting oils and grease to roll off with water rinse.

A plan for this unique storage tank-cleaning method is furnished free and an Oakite Technical Service Representative will help you install it. For more complete information about Oakite Solvent Detergents, write for FREE booklet. Address: Oakite Products, Inc., 50D Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. & Canada

(To obtain more data on advertised products see page 776)

ORONITE
LUBE OIL
ADDITIVES

Showing auto fitted with radio-activity gear to record instantaneous performance of oils compounded with Oronite additives. Tests are made under all types of driving conditions.

tested with radio-activity under field operating conditions

Oronite was first to make practical engine use of radio-activity to develop superior lubricating oil additives. This science has progressed far at Oronite in the past few years. Today, radio-activity is employed under all types of actual operating conditions to gain instantaneous measurements from oils compounded from Oronite additives—to provide you with even more advanced additives.

The research and testing facilities behind Oronite additives are the most advanced in the nation. With this years-ahead research it is possible that Oronite could provide your finished oil with competitive advantages you need to win and hold a market.

Oronite will tailor-make additives to your base oils—meeting your price and performance specifications.

See what Oronite additives can offer you. Just contact the Oronite office nearest you.

With Oronite Additives you can formulate oils to meet the new A.P.I. Service Classifications and can meet specifications for 2-104-B, MIL-O-2104, Supplement I and Series 2 oils.

OTHER ORONITE PRODUCTS

Gas Odorants
Polybutenes
Phenol
Wetting Agents
Dispersant FO
(Furnace Oil Inhibitor)

ORONITE CHEMICAL COMPANY

38 Sansome Street, San Francisco 4, California
30 Rockefeller Plaza, New York 20, New York
600 South Michigan Avenue, Chicago 5, Illinois
714 W. Olympic Blvd., Los Angeles 15, California
Merchantile Securities Building, Dallas 1, Texas

ORONITE CHEMICAL COMPANY

What's New!

Self-Operated Flow Regulator

. . . which operates by means of energy derived from the fluid stream itself; *Catalog* 10-*F*-70 gives operation description and cutaway drawings, plus list of suggested applications. Fischer & Porter Co., 49 Jacksonville Rd., Hatboro, Pa.

Circle No. **37** *on Reply Card*

Pressure-Regulating Valves

. . . and relief valves; *Catalog* 207 contains capacity charts for all types, construction information, and chart giving thermodynamic properties of saturated steam. Schade Valve Mfg. Co., 2527-37 N. Bodine St., Philadelphia 33, Pa.

Circle No. **38** *on Reply Card*

Alloy Tubing Steel

. . . for high-temperature service where high corrosion resistance is important; composition of Croloy 9M, 8 to 10% chromium, 1% molybdenum; *TDC* 151 gives mechanical and physical properties, and data on bending, welding and heat treatment. Tubular Products Division, Babcock & Wilcox Co., Beaver Falls, Pa.

Circle No. **39** *on Reply Card*

Water-Treating Equipment

. . . for various uses including as oil-water separators in treatment of refinery wastes; *Bulletin AH*-442 contains illustrations of circular clarifiers and different types of filters, as well as flow sheets. Hardinge Co., York, Pa.

Circle No. **40** *on Reply Card*

Heat-Resisting Finishes

. . . with ability to withstand temperatures to 1600° F.; *Technical Bulletin No.* 5311 lists protective properties and heat-resisting qualities of each type paint. General Paint Corp., 2627 Army St., San Francisco 19, Calif.

Circle No. **41** *on Reply Card*

Fittings and Flanges

. . . general catalog; 304 pages containing dimensions and specifications on complete line; data tables on allowable stress, P/S values and maximum working pressures; tabulation of material specifications for non-ferrous metals generally used in piping systems, with nominal composition and minimum physical requirements of these materials. Write direct to the Ladish Co., Cudahy, Wis.

Do Not Use Reply Card

(To obtain more data on advertised products see page 776)

POLYRAD CONTROLS ACID CORROSION

Chemical Inhibitor Also a Detergent

More and more refineries are finding Polyrad an excellent inhibitor in the control of internal corrosion and plugging of equipment. Polyrad, a development of Hercules research, helps maintain throughput, increases heat transfer, reduces metal loss, and cuts downtime for maintenance.

A derivative of an organic amine, Polyrad forms a molecular film that shields refinery equipment from hydrogen-ion attack by organic and inorganic acids. It functions efficiently under acid conditions—low concentrations giving better than 99 percent protection to mild steel immersed in strong hydrochloric acid. It can also be used in conjunction with ammonia or alkalies and is effective up to 500°F. Polyrad economically controls corrosion in the refinery—from crude units to gas plant areas.

The detergent action of Polyrad is a unique plus feature. It loosens iron sulfide and other scales; permits them to be dispersed in the fluid stream and removed from process equipment.

Polyrad is readily available from stocks carried at convenient locations. For further information, write Hercules.

POLYRAD®

A Hercules Rosin Amine Derivative

Naval Stores Department
HERCULES POWDER COMPANY
983 Market Street, Wilmington 99, Del.

 (To obtain more data on advertised products see page 776)

TOWER CAPACITY RESTORED IN ONE DAY BY CHEMICAL CLEANING

Through-put increased from 500 to 800 gallons per minute by Dowell Service

The capacity of a fractionating bubble-cap tower, operated by a southern chemical company, had dropped from 800 to 500 gallons per minute. Heavy deposits covered the traps and clogged the bubble-caps. Dowell engineers analyzed these deposits and found them to be iron sulphides, oxides and organic material.

Dowell Service removed these deposits from the tower in only one day with specially prepared liquid solvents. Result: the tower was restored to its original 800 g.p.m. capacity.

In the Dowell method of chemical cleaning, solvents are applied according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Being liquid, they will go wherever steam or water will flow, reaching surfaces inaccessible to other cleaning methods. No special scaffolding is required. Dismantling and downtime are kept to a minimum. Experienced Dowell engineers do the job for you using Dowell-designed pump trucks and control equipment which are brought right into your plant.

Towers are just one of hundreds of pieces of industrial equipment which can be cleaned chemically by Dowell Service. For complete information and estimates on the cleaning of your equipment, call the nearest Dowell office, or write directly to Tulsa, Dept. E-32.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED · TULSA 1, OKLAHOMA

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

 (To obtain more data on advertised products see page 776)

Organic Chemicals

. . . and their physical properties; *Catalog* 54-1 contains full details on more than 80 commercial, semi-commercial and laboratory chemicals produced by the company. Sharples Chemicals, Inc., Widener Bldg., Philadelphia 7, Pa.

Circle No. **42** *on Reply Card*

Controlled Volume Pump

. . . with capacity up to 1350 gph. and pressure up to 50,000 psi.; *Bulletin* 1153-*A* describes new features and gives construction details of the "HyROYmetric" model. Milton Roy Co., Station L, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle No. **43** *on Reply Card*

Blast Cleaning Supplies

. . . and accessories; *Bulletin* 300C describes helmets, gloves, hoses, nozzles, aprons and repair parts, with several pages on abrasives for different cleaning jobs. Pangborn Corp., Hagerstown, Md.

Circle No. **44** *on Reply Card*

Stainless Steel

. . . in chemical processing; 34-page booklet describes its value in the manufacture of different chemical products, also provides corrosion resistance data, fabricating information and a stainless steel selection guide. Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 19, Penna.

Circle No. **45** *on Reply Card*

Metal Primer

. . . which can be applied directly over rusted surfaces to stop rust action, "Ospho"; leaflet gives chemical composition and reaction with rust, and prices. Rusticide Products Co., 3125 Perkins Ave., Cleveland 14, Ohio.

Circle No. **46** *on Reply Card*

"Jacketless" Jacketed Fittings

. . . are made possible by a new heat transfer medium and technique for valves and fittings which provide a less expensive substitute for conventional steam jacketing: consisting essentially of an insulating type cement which can be set around tubing which has been coiled around the fitting; described in four-page folder. Thermon Mfg. Co., P.O. Box 3027, Pasadena, Texas.

Circle No. **47** *on Reply Card*

Carbon Monoxide Analyzer

. . . to warn against dangerous concentrations, automatic operation; 4-page leaflet describes new electronic device and gives specifications. Taller & Cooper, Inc., 75 Front St., Brooklyn, N. Y.

Circle No. **48** *on Reply Card*

Viscometer Operation

. . . and its use and maintenance; booklet, "Solutions to Sticky Problems," contains full details, construction diagrams for Brookfield Viscometer. Brookfield Engineering Laboratories, Inc., Stoughton, Mass.

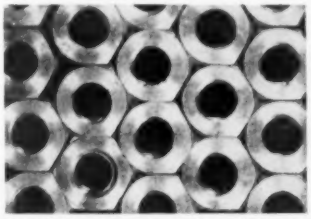
Circle No. **49** *on Reply Card*

Iron Gate Valves

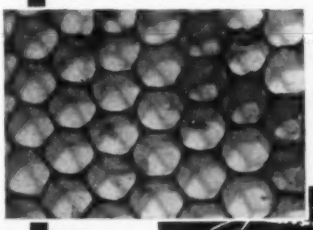
. . . of the wedge-type; *Bulletin* 107 gives full operating details, list of types available. Kennedy Valve Mfg. Co., Elmira, N. Y.

Circle No. **50** *on Reply Card*

SIX SIDED SYMBOLS of fabricated strength



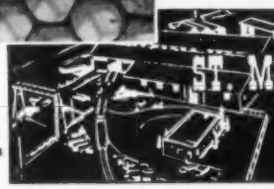
Honeycomb and brass hex nut . . both are fabricated for strength and special purpose



St. Mary fabricating engineers, like those in nature, build strong industrial structures for special purposes. For tanks, pressure vessels or steel buildings, the following industries know St. Mary Iron Works well:

RICE SUGAR TUNG SALT FISH SULPHUR
PETROCHEMICALS WATER TRANSPORTATION

For special or general purpose steel fabrication, consult St. Mary engineers today.

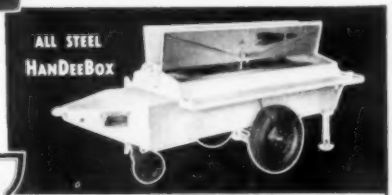


ST. MARY IRON WORKS
Steel Fabricators for Half A Century
FRANKLIN, LOUISIANA - U. S. A.

REFINERY MAINTENANCE CREWS DEPEND ON LITTLEFORD ALL STEEL PORTABLE TOOL BOXES

Model 55 All Steel Tool Box is the maintenance crew helper. It is used for transportation and storage of tools, one tool box can be used for each pipe tapping machine and its accessories. When tools are needed this fast trailing Model 55 Tool Box is ready to go—no delays. Tools do not have to be checked in or out everyday, they're assigned to the maintenance crew and they use them continuously. By using a towing hitch three or four Tool Boxes can be transported at one time. These Model 55 All Steel Tool Boxes are saving Refineries thousands of dollars. Modernize your maintenance crews with this fireproof—thiefproof Tool Box—it's a low cost investment.

Equipment with BUILT-IN ENGINEERING LITTLEFORD

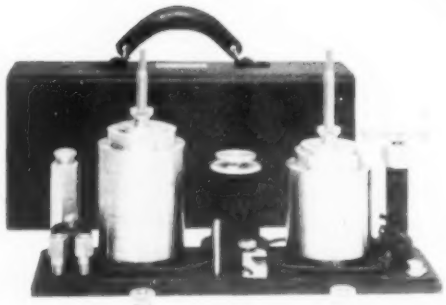


LB LITTLEFORD
LITTLEFORD BROS., INC.
446 E. Pearl St., Cincinnati 2, Ohio

Here's the 8 ft. Weatherproof, Thiefproof and Fireproof All Steel Tool Box for transporting valuable tools or for leaving tools on the job over night. It's a low cost labor saver for maintenance crews.

(To obtain more data on advertised products see page 776)

R. S. PORTABLE DEAD WEIGHT TESTER



for accurate testing of high pressure

up to 5,000 psi

The only truly portable dead weight tester of this capacity.

An extremely compact instrument for pressure gage testing and calibration to pressures of 5,000 psi. Standard Accessories include an adaptor so the tester may also be used as a dead weight gage. Can be furnished in ranges of 5-1000 psi or 50-5000 psi.

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Cenco . . . one dependable source of supply for everything you need in scientific instruments and laboratory supplies. Over 15,000 items . . . 14 branch offices and warehouses.

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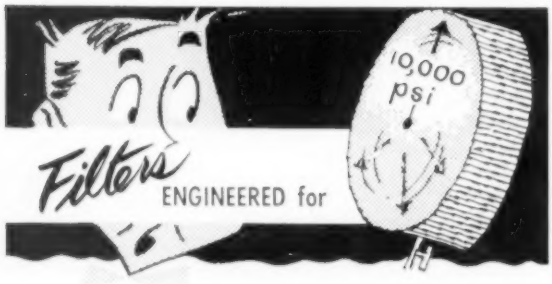
1700 IRVING PARK ROAD ● CHICAGO 13, ILLINOIS
CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO
SANTA CLARA LOS ANGELES TORONTO MONTREAL VANCOUVER OTTAWA



High Pressure Service

- Up to 10,000 PSI
- Permanent Filter Element (Porous Stainless Steel or Porous *Fluorocarbon)
- In Line Construction
- Low Pressure Drop
- Corrosion resistant All Stainless Steel Code Construction
- For Liquids and Gases

Write for Bulletin No. 31B

Another filtration engineering service of

MICRO METALLIC CORPORATION
52L Sea Cliff Ave. Glen Cove, N. Y.

PALL

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ANNOUNCING
THE THIRD ANNUAL PETROCHEMICAL MARKETS ISSUE

The July issue of *Petroleum Processing* is your key to the tremendously expanding Petrochemical Industry. In 1953 approximately 25% of all chemicals were petrochemicals. By 1962, just 10 years, it is estimated that 50% of all chemicals produced will be petrochemicals. This will make necessary a huge expansion program which points up the almost unlimited market for all types of equipment—i.e. furnaces, heat exchangers, fractionating towers, pumps, valves, pipes and tubes, fittings, of many types, controls and instruments and many more materials and process equipment.

***Petroleum Processing* is your key to this market because *all* classes of refinery buying influences—management, engineers, foreman—depend on *Petroleum Processing* to keep them informed on new developments in plant equipment and processes.**

To find out how you can participate in this, the biggest publishing event of the year in petrochemicals, contact your nearest *Petroleum Processing* representative, as listed on page 625 or write direct to:

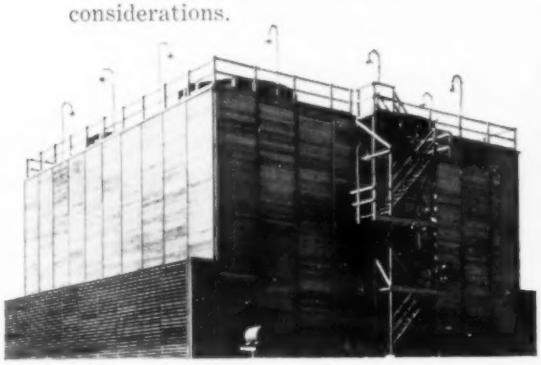
PETROLEUM PROCESSING
NOW
330 West 42nd Street, New York 36, N. Y.

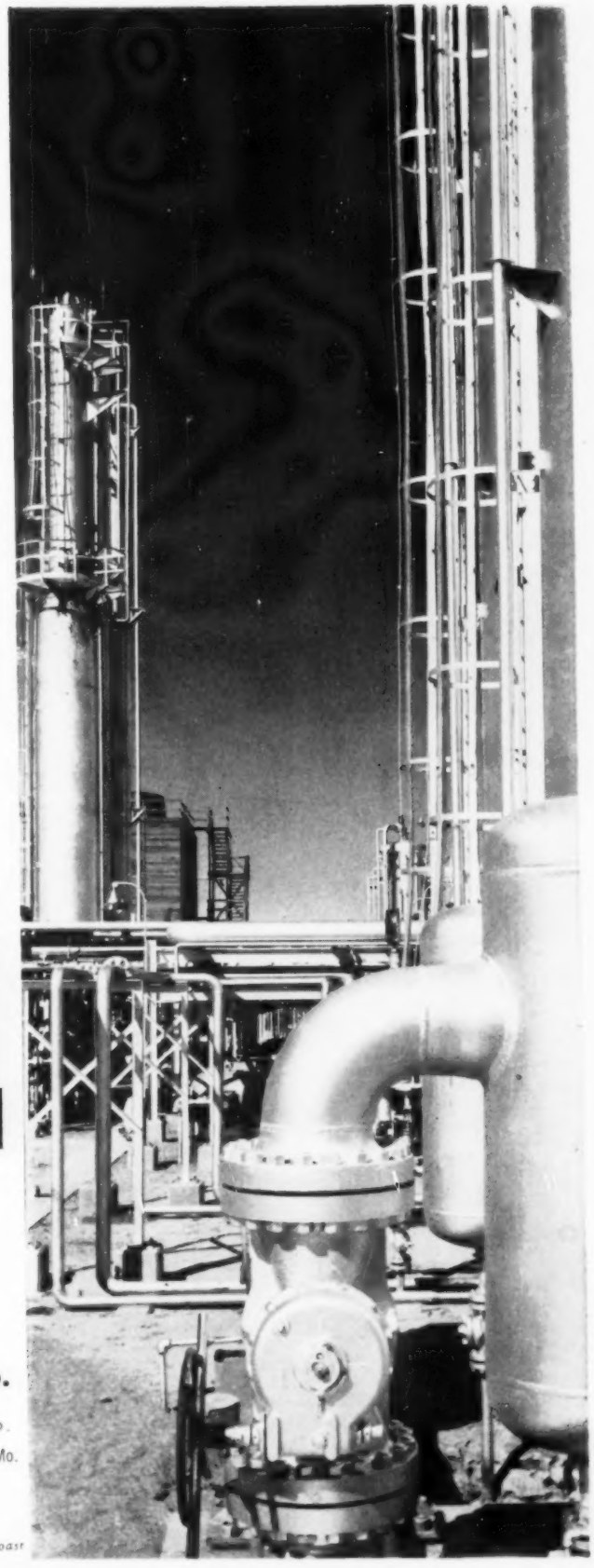
TALL TOWERS NEED COOL WATER

The best way to cool water for your vital refinery processes is with Pritchard heavy-duty cooling towers.

Why Pritchard towers? First, because you want your initial investment to be economical. Second, because you want each tower to do the job it was designed to do with maximum operating efficiency and water savings . . . minimum operating expense and maintenance costs.

You can depend on Pritchard to satisfy these two important considerations.





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GAS & AIR TREATING EQUIPMENT

Representatives in Principal Cities from Coast to Coast

The Lowest Cost Corrosion Resistant Conduit for Plants Like These is ALCOA ALUMINUM RIGID CONDUIT

Alcoa® Aluminum Rigid Conduit, especially resistant to industrial atmospheres that often attack other metals, costs less than any other corrosion resistant conduit. The excellent performance of aluminum conduit in corrosive conditions means lower maintenance costs and less frequent replacement.

In addition, Alcoa Aluminum Rigid Conduit is nonmagnetic, lowers voltage drop, eliminates overcrowding of terminal enclosures and simplifies the installation of electrical equipment having widely spaced terminals.

Alcoa Aluminum Rigid Conduit reduces handling, fabricating and installation costs. It is only about one-third the weight of the same size in steel. A 10′ length of the 4″ size weighs only 33 pounds and can easily be handled by one man.

Alcoa Aluminum Rigid Conduit is approved by Underwriters' Laboratories, Inc. and each piece bears their label. Readily available. Call your local Alcoa sales office, listed under "Aluminum" in your classified directory. ALUMINUM COMPANY OF AMERICA, 2093-E Alcoa Building, Pittsburgh 19, Pennsylvania.

For complete information write for Alcoa's new booklet, *Alcoa Aluminum Electrical Rigid Conduit.*

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

(To obtain more data on advertised products see page 776)

Surface Protection System

. . . for tanks, storage vessels and tank cars; *Technical Bulletin* 5310 describes paint primers, coatings and trim recommended in the system prescribed for each use, also gives data on surface preparation, priming and application of finish and trim coats. General Paint Corp., 2627 Army St., San Francisco 19, Calif.

Circle No. **51** *on Reply Card*

Motorized Valves

. . . and control motors; *Catalog* 8203 covers complete line, gives specifications, ordering information, prices; also, details on use of motors with globe, adjustable port, butterfly valves or combinations. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **52** *on Reply Card*

Diaphragm Motor Valves

. . . with double and single seated, low flow, Venturi and 3-way bodies; *Catalog* 800 gives complete specifications and features of each type. Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **53** *on Reply Card*

Controlled Volume Pumps

. . . in the petroleum industry; *Technical Paper No.* 62—reprint from PETROLEUM PROCESSING — explains what they are, how they work, and how they are used as flow control instruments in typical refinery applications, e.g., pH control, fuel oil treating, crude desalting and sampling. Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Pa., Sta. K.

Circle No. **54** *on Reply Card*

Industrial Equipment

. . . including condensers, compressors, engines, steam power plant equipment and pumps, are described in *Bulletin WP*-1099-*B*61; information is given on sizes, capacities, applications. Worthington Corp., Harrison, N. J.

Circle No. **55** *on Reply Card*

Recording Oscillographs

. . . galvanometers and accessories are described in *Bulletin CEC*-1500*C*; full information on operating features of Model 5-114 oscillograph. Consolidated Engrg. Corp., Inc., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle No. **56** *on Reply Card*

Continuous H_2 Analyzer

. . . works in mixtures with air or hydrocarbons; *Bulletin* 301 gives operating details, schematic diagram. Taller & Cooper, Inc., 75 front St., Brooklyn 1, N. Y.

Circle No. **57** *on Reply Card*

Processing Equipment

. . . and heat-treating equipment, light-weight; *Catalog* 54 has company's complete line, fully illustrated; also includes list of company's entire stock of bubble caps and risers. The Pressed Steel Co., Wilkes-Barre, Pa.

Circle No. **58** *on Reply Card*

Steam Traps

. . . are described in *Condensed Bulletin* 154; containing specifications and pressures, weights, and list prices. The V. D. Anderson Co., 1935 W. 96th St., Cleveland 2, Ohio.

Circle No. **59** *on Reply Card*

In today's fast-moving economy, you must have speed . . . speed in refining . . . speed in marketing, to keep abreast of competition. When you remodel or build a new plant, you want the job done quickly and efficiently, to get back into production.

REFINERY ENGINEERING Company has the reputation of getting the job done on schedule, *or before.* When you place a contract with TRECO, you want *and will receive* careful planning and engineering, sound workmanship and *speed of construction.*

Why don't you let us discuss with you, the remodeling of your present facilities or the building of a complete new refinery? No job is too small nor too large to receive the complete attention of every member of the TRECO staff. That is why ninety seven per cent of all TRECO customers give us repeat business.

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REFINERY ENGINEERING Company
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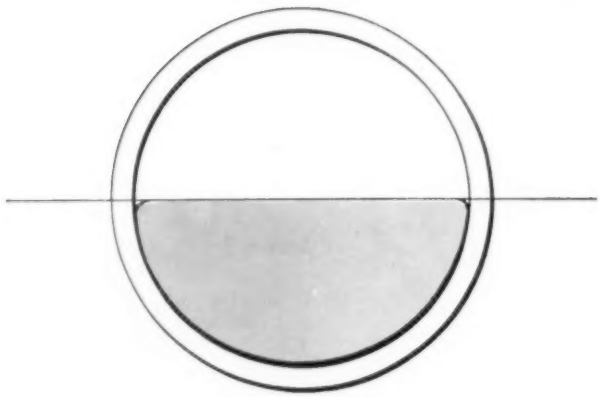
(To obtain more data on advertised products see page 776)



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The hundreds of feet of pipeline used in the manufacture of paint and varnish are kept open by constantly purging them with inert gas. The gas prohibits oxygen from entering the lines, thus the varnishes have no opportunity to dry or clog the system.

Formerly these inert gases were either a by-product of one of the plant's operations or they were purchased in containers from gas suppliers. Today, with modern plants, decentralization that tends to divide the multifold operations of larger concerns and the great advancement in inert gas generation, manufacturers are finding they can make their own gas at much lower rates from small compact generating systems.

Gas Atmospheres, Inc., has developed a "packaged" system that makes just the type of gas the job calls for in whatever amounts required. It is inexpensive to operate and requires little space. It's neat, clean, quick and easy.

Write today! Let us know the amounts required and we'll show you just how fast this equipment will pay for itself.

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CANCER OF THE LUNG...?

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DOCTORS ESTIMATE that 50% of all men who develop lung cancer could be cured if treated in time. But we are actually saving only 5%... just one-tenth as many as we should.

WHY—? Many reasons. But one of the most important is not enough money . . . for mobile X-ray units, for diagnosis and treatment facilities, for training technicians and physicians.

THESE ARE JUST A FEW of the reasons why *you* should contribute generously to the American Cancer Society. Please do it now! *Your* donation is needed —and urgently needed—for the fight against cancer is *everybody's* fight.

Cancer
MAN'S CRUELEST ENEMY
Strike back—Give
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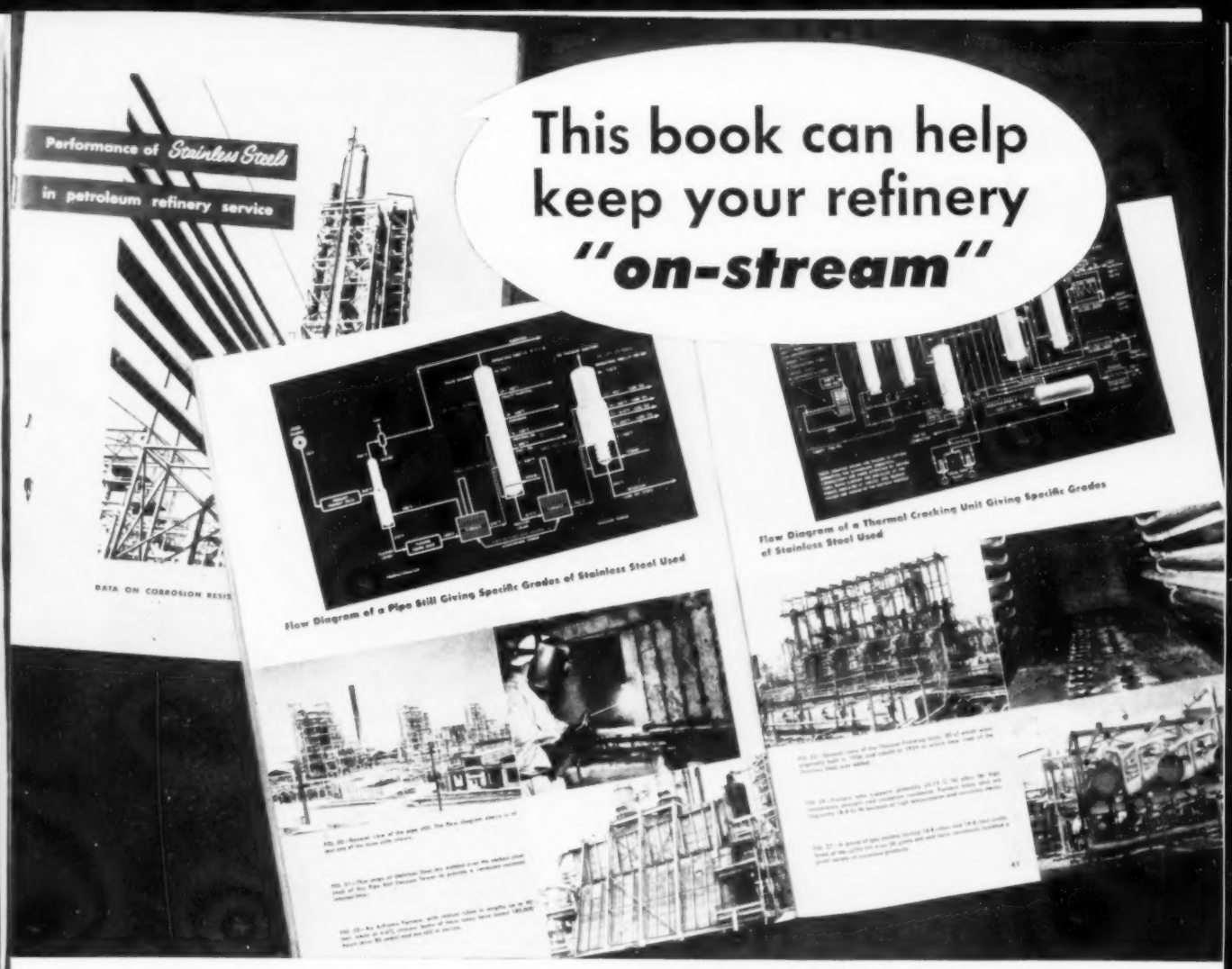
(To obtain more data on advertised products see page 776)


Performance of Stainless Steels
in petroleum refinery service
This book can help keep your refinery "on-stream"
Flow Diagram of a Pipe Still Giving Specific Grades of Stainless Steel Used
Flow Diagram of a Thermal Cracking Unit Giving Specific Grades of Stainless Steel Used

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With Stainless Steel playing such an important role in your never-ending fight against down time, here is just the information you need to use this valuable material most effectively.

It's United States Steel's new book, "Performance of Stainless Steel in Petroleum Refinery Service." Based on the actual experience of some of America's largest refineries with Stainless Steel, it presents one of the most comprehensive studies ever made of application of Stainless Steel to the petroleum industry.

It discusses fully all types of corrosion—atmospheric, wet chemical, elevated temperature and such forms of intergranular corrosion as carbide precipitation, attack by molten metals and sulphur attack.

It presents strength data on 14 of the grades of U·S·S Stainless Steel most frequently used in high temperature service.

And, finally, it gives you flow diagrams of processes in use in major refineries, showing exactly where Stainless Steel is used. These processes include Thermal Cracking Units, Lube Oil Extraction Plants, Pipe Stills and Fluid Catalytic Cracking Units.

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4-65

UNITED STATES STEEL

United States Steel Corporation,
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Pittsburgh 30, Pa.

Please send me my copy of "Performance of Stainless Steel in Petroleum Refinery Service."

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At The Atlantic Refining Company's plant in Philadelphia, alkyl aryl sulfonates are evaporated in Monel evaporators. Atlantic uses corrosion-resisting Monel in condensers on benzene distillation equipment, piping, neutralization tank, settler, soap evaporators, solvent extraction equipment, steam coils in Ultrawet storage tanks and in tanks for storing 50% caustic soda.

How Monel protects against corrosion in

Synthetic Detergent Manufacture

It's no wonder that The Atlantic Refining Company, one of the largest detergent manufacturers in the country, relies heavily on corrosion-resisting Monel to protect important process equipment items against corrosion and to insure the high purity of its synthetic detergent "Ultrawet."

For there are plenty of places where corrosion can take hold in the manufacture of alkyl aryl sulfonate detergents.

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Service in many fields has proved that Monel is often the most economical material where a strong, tough alloy is needed to handle acids, alkalies and salts with a minimum of corrosion or contamination. Monel is an easily-formed structural material whose corrosion resistance is not impaired by welding.

If you would like to know whether Monel or one of the other Inco Nickel Alloys can help solve your corrosion problem, write to Inco's Corrosion Engineering Section. Our Technical Bulletin T-5 "Engineering Properties of Monel and 'R' Monel" is yours for the asking.

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MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
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Did You Miss These?

The following items, reviewed originally in April, have aroused considerable interest among the readers. They are repeated briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

Liquid Feeder Eliminates the Need for Proportioning Pumps

. . . because of a built-in ejector. The new "Feedrator" is designed for simultaneously metering, controlling, mixing, and dispensing small quantities of liquid chemicals into liquid streams. A pressure differential in the main line, to create a by-pass flow through the ejector, is all that is necessary to operate the unit. Many corrosive chemicals can be fed directly into the main process stream because the unit is enclosed in a Lucite block. For additives which Lucite cannot handle satisfactorily, the block is also available in Uscolite at some additional cost. Small size of the body block—4¼ x 2¾ in.—affords ease of mounting. The pipeline adaptor screws directly into the body block also. By-pass flow required is relatively small. Injection flow is controlled precisely with the needle valve. The unit comes in four standard models with capacities ranging from 0.03-0.3 to 2-20 gal./hr. A small ball check valve provides protection against sudden pressure drops. Fischer & Porter Co., 19 Jacksonville Rd., Hatboro, Penna.

Circle No. **60** *on Reply Card*

Torque-type Viscometer Permits Continuous Process Control

. . . in a flow-line by-pass, or a processing vessel. It can be used for base mount temperatures up to 200° F. and in pressure conditions from 8 mm. Hg. vacuum to 100 psi. All moving parts of the "Viscometran" are mounted on rigid aluminum castings and enclosed by a 3/32-in. steel valve cap. The base, also cast for maximum strength, is hinged so the spindle can be removed quickly for inspection, range change, or cleaning. The instrument is mounted on a 4-in., 125-lb. standard American pipe flange. In use, the spindle is rotated by a synchronous motor at a constant speed in the liquid under test. The torque required to produce this rotation is directly proportional to the centipoise viscosity of the fluid. Using either a

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ASPHALT SPECIALTIES

WEATHERCOAT
Slows Weathering

WEATHER and WATER can't affect the protective qualities of Weathercoat: this tough ductile asphaltic coating *bridges* expansion, but remains firm under heat or cold.

That's why Weathercoat is preferred by most of the world's largest refineries* for protection of exposed insulation on fractionating columns, crude stills and tanks . . . for sealing insulation joints . . . exposed insulated pipelines . . . for membranes in reservoirs.

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Brush, trowel or spray Weathercoat —it's easy—"palms" beautifully over uneven surfaces!

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COMPANY

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E. Providence 14, R. I. Perth Amboy, N. J. Baltimore 3, Md. Mobile, Ala. Columbus 15, Ohio
Tucson, Ariz. Seattle, Wash. Baton Rouge 2, La. St. Louis 17, Mo. Inglewood, Calif.
Oakland 1, Calif. Portland 7, Ore. Washington 6, D. C. San Juan 23, P. R.

(To obtain more data on advertised products see page 776)

SALES ENGINEERS

New York District Office

We need two graduate Chemical Engineers with at least five years experience in Oil Refining or Petrochemical Manufacture. To these men we offer responsible and interesting positions as members of our expanding New York staff. The work entails some travel. The compensation is straight salary and expenses. The future is limited only by the men's own ability to produce.

The men we need have technical ability, plus a good personality. On the technical side, our men have a broad general knowledge of heat-transfer, fractionation, and of process-applications. This knowledge must be based to a large extent on actual experience. On the personal side, they are between 30 and 40 years old. They are aggressive. They are friendly, and like to meet new people. They are sincerely interested in a permanent career in Sales Engineering.

If you believe you're fully qualified, please write to us at 630 Fifth Avenue, New York 20, New York. We'll acknowledge your letter and arrange to talk with all who seem to fill our needs. We'll respect your confidence. Please do not phone or call in person. Last time we tried it, our Reception Room looked like Grand Central. And our switchboard operator quit.

C. F. BRAUN & COMPANY

630—5th Ave., N. Y. 20, N. Y.

NEW CLOUD and POUR TEST Unit for... Faster Lower Cost Testing!

- *Designed for testing to ASTM D97 Specs.*
- *Individually controlled separate baths for range +30°F to −90°F.*
- *Each bath refrigerated by its own hermetically sealed compressor.*

Recessed wells eliminate temperature variations, icing around samples

Murphy & Miller 2 and 3 section cabinets feature individually controlled and refrigerated wells to provide maximum test flexibility and greater accuracy in temperature control. Heavily insulated cabinets and covers reduce operating costs . . . hermetically sealed compressors (with 5 year warranty) minimize maintenance. Unique recessed well design isolates samples from room temperatures . . . eliminates temperature variations and icing and permits faster, easier sample loading and handling . . . more accurate reading of samples. Write for illustrated circular and specifications.

MURPHY & MILLER, Inc.

1354 So. Michigan Avenue · Chicago 5, Illinois

variable capacitance or a variable resistance, the Viscometran transmits a viscosity signal to a suitable receiver by sending an electrical impulse proportional to the torque. Viscosity is measured at a constant rate of shear because of the constant spindle speed. Brookfield Engrg. Labs., Inc., 240 Cushing St., Stoughton, Mass.

Circle No. **61** *on Reply Card*

Ventilation Engineering

. . . information is provided in *Bulletin A*-108; fan laws and formulae, terms and definitions, recommended velocities for exhaust hoods, an air pressure conversion table, and charts covering duct resistance, entrance losses, and rectangular equivalents of round ducts are included; also, installation, maintenance and lubrication. Hartzell Propeller Fan Co., Piqua, Ohio.

Circle No. **62** *on Reply Card*

Ammonia From Natural Gas

. . . plants, yield and cost data, principal operating features and the economics of a process design utilizing the high pressure of natural gas; 8-page booklet. M. W. Kellogg Co., 225 Broadway, New York 7, N. Y.

Circle No. **63** *on Reply Card*

Pressure Loss Calculator

. . . for steam valves; slide chart estimates pressure drop and indicates proper size steam valve needed for any pressures up to 1500 psi.; full operating instructions and necessary technical data are printed on the calculator. Golden-Anderson Valve Specialty Co., 1264 Ridge Ave., Pittsburgh 33, Pa.

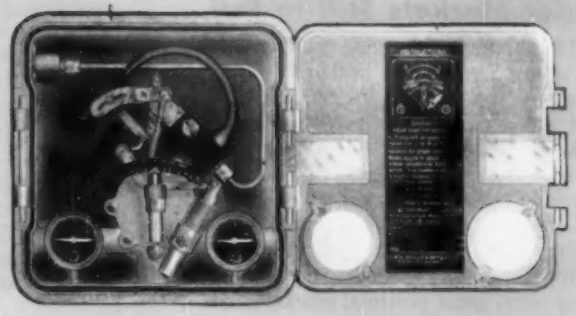
Circle No. **64** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of Petroleum Processing to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item. Then fill in the rest of the card and drop it in the mail. No postage is required.

BS&B Announces:

. . . An Even Better Pressure Controller — Climax Type 1440



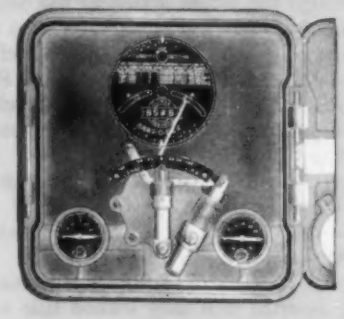
The Climax Type 1440 Pressure Controller (non-recording) is designed to handle both positive and negative pressures, from high vacuum to pressures of up to 10,000 lbs. Bourdon Tube actuated — with all tubes, bellows assemblies, feed orifices and bleed nozzles calibrated — the Type 1440 is an instrument of utmost accuracy. Proportional band and On-Off or Maximum-Minimum snap action adjustment is easily made without additional parts. Snap action may be adjusted to pressures up to 75% of the limits of the Bourdon Tube rating.

Improved Features of Types 1440 and 1450:

1. Weatherproof case of die-cast aluminum designed for universal mounting.
2. Compact size — 8" x 8" x 4".
3. Door hinges to left or right, as desired.
4. Straight line piping.
5. Proportional bellows, calibrated, spring opposed.
6. Micro-adjusted set-point, graduated.
7. Molded diaphragms in power unit.
8. Easy parts replacement or assembly.
9. Feed orifice cleaner.
10. Snap action available over 10% to 75% of tube range without additional parts. (Applies to Type 1440 only.)
11. Pilot action reversible by moving a single link, without tools.
12. Elimination of superfluous linkages, resulting in easier adjustability and greater sensitivity.

Types 1440 and 1450 Have Been Developed and Thoroughly Field Tested for More Than Two Years!

. . . An Even Better Liquid Level Controller Pilot . . . Climax Type 1450



The type 1450 Liquid Level Controller Pilot was developed for use and mounting on any Climax Type 888, 888-LF, 887 and 889 displacement liquid level controllers where a torsion tube transmits float movements to reflect changes in liquid level or a change in gravity of the controlled liquid. Its interchangeability of parts with those of the Type 1440 Pressure Controller is an advantage which reduces stocking parts.

Type 1450 features a very wide "throttling" range calibrated from 0% to 100%. A specific gravity index is provided and offers a method of compensating for various gravities of liquids, or for inter-face services, where the "throttling" range is kept exact in its relationship to the specific gravity setting.

A novel feature of the Type 1450 is its adjustability, without use of special parts, for "snap" or "on-off" action. This is useful when it becomes desirable for the diaphragm control valve to fully open or close when liquid level height reaches a desired "high" setting, and to react in an opposite manner at a desired "low" setting. The amount of liquid level change from open to shut positions of the control valve may be varied up to 75% of displacement element length.

Types 1440 and 1450 are but a small part of the complete Climax line—designed, engineered and precision manufactured by BS&B to meet your most exacting requirements. Send for your free copy of the complete Climax catalog!

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EDITORIALS . . .

Wider Markets Still to Sell

REFINERS have been so occupied the past two years with the problems of surplus capacity and large volumes of product stocks, that there is the possibility some will lose a true perspective of the industry's future markets.

An encouraging evaluation of the factors that create petroleum demand was presented by Charles J. Hedlund, head of the Petroleum Economics Division, Standard Oil Co. (N. J.), in a recent talk before the Financial Analysts Society of Philadelphia. He believes that over a long term, great potential markets exist in this country as well as in foreign nations.

"Many of us who venture out on a weekend on the crowded highways surrounding our metropolitan areas wonder whether any more automobiles can be sold at all," said Mr. Hedlund. Actually, he pointed out, only 30,000,000 families in the U. S., or about 65% of all households, owned a car in 1953. Of all U. S. farms, 25% have neither a car nor a truck.

In 1953, despite increased consumption of natural gas, about 800,000 new oil burners were installed, said Mr. Hedlund, "and millions of homes still have outmoded heating equipment." Among such uses as aviation, trucks, buses, diesel engines, LPG and petrochemicals, many still retain a strong growth potential, despite their large past expansion.

The markets are there, but the competition for them may be keen, the Philadelphia economists were told, because of the present ample availability of crude, refining capacity and transportation facilities. This sharpened competition is already being recognized by both large and small refiners in their technological programs for product quality improvement and the reduction of plant operating and maintenance costs.

Economist Hedlund's views on the future are buttressed by the industry's past development. The coming competition among oil companies need not all be dog-eat-dog for existing markets. Still ahead are wider markets that many individual refiners will develop to their greater profit.

Underground Emergency Storage?

IN its current study of the industry's storage capacity for crude and refined products for the defense authorities, the National Petroleum Council is including underground reservoirs along with above-surface tankage. Underground cavities have been used by the oil companies for product storage for relatively few years, but various kinds of these reservoirs are already in service. As yet, however, they provide only a very small proportion of the volume that would be required if this type of storage were to come into wide scale use.

Since World War II, the question of storing petroleum supplies in large volume against the outbreak of war or some great emergency, has been mostly in terms of steel tankage. The growing use of underground caverns, or pits such as abandoned quarries, presents a new factor in these considerations. These reservoirs offer some special advantages for emergency storage.

They are located some distance from refineries and congested areas that would be subject to bombing. They would be easy to camouflage. In most cases they would have the capacity for larger volumes than a single refiner could handle. Thus they would be fitted for a cooperative project such as defense storage likely would be. Original and maintenance costs would be lower than for steel tanks. The use of natural reservoirs, if feasible, would not call on the steel that refiners might need to expand their own product marketing systems. Some factors in the use of underground cavities need to be determined, such as contamination of product and deterioration in long term storage.

The inclusion of underground storage in the survey of the National Petroleum Council is timely. It should emphasize to the military and defense authorities the importance of including this type of petroleum storage in their considerations, and it might head up their conclusions on the subject of emergency inventories.

Tidelands Question—Who Really Won?

IT looks as though the recent action of the Supreme Court has finally settled the question of who really owns the Tidelands oil. The Court settled it by refusing to declare unconstitutional, as requested by Rhode Island and Alabama, the so-called 1953 Tideland's legislation, granting title to the submerged land resources to the States.

Of course, the ultimate decision was arrived at in a little roundabout manner, and there might be some question as to who really won its point—the States or the Federal Government.

The States most concerned (Texas, California and Louisiana) have asserted that they owned title to the tidelands resources all along, and that the Federal Government had no right to take it away from them.

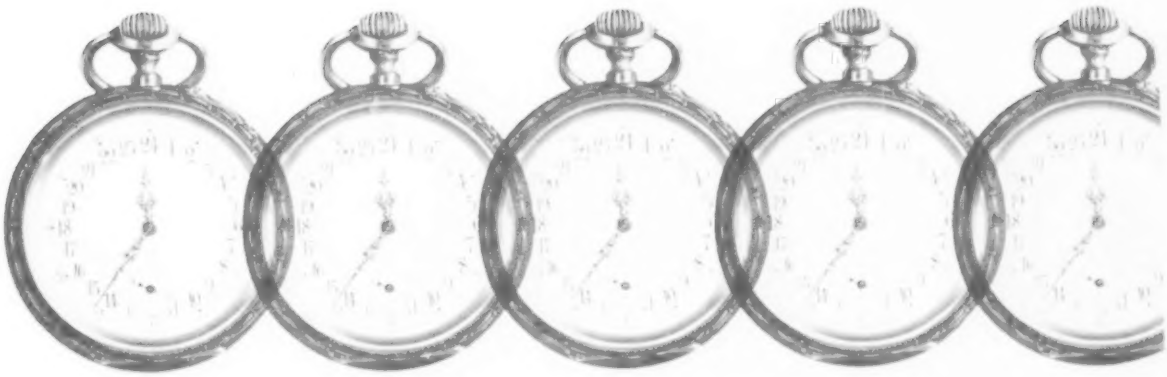
The Federal Government, on the other hand, has claimed that it "owned" these resources. And that latter opinion was finally upheld by a Supreme Court decision in 1950 to the effect that the Federal Government alone had "paramount rights" to off-shore resources.

So what did Congress do but turn around, once the Supreme Court had decided that the title really belonged to the Federal Government, and "give" that title to the states. Please note that Congress didn't "give back" title, and that nowhere along the line has the State viewpoint that it always owned title ever been upheld.

All the latest Supreme Court decision did was to reaffirm the right of Congress to dispose of any U. S. property "without limitation," and the decision didn't in any manner upset the earlier decision on the doctrine of "paramount rights."

It looks to us as though the Federal Government really won its point—that it always owned the tidelands resources. But now that the States finally do have title, the question of who really won is academic —although interesting.

You're Just Hours Away...



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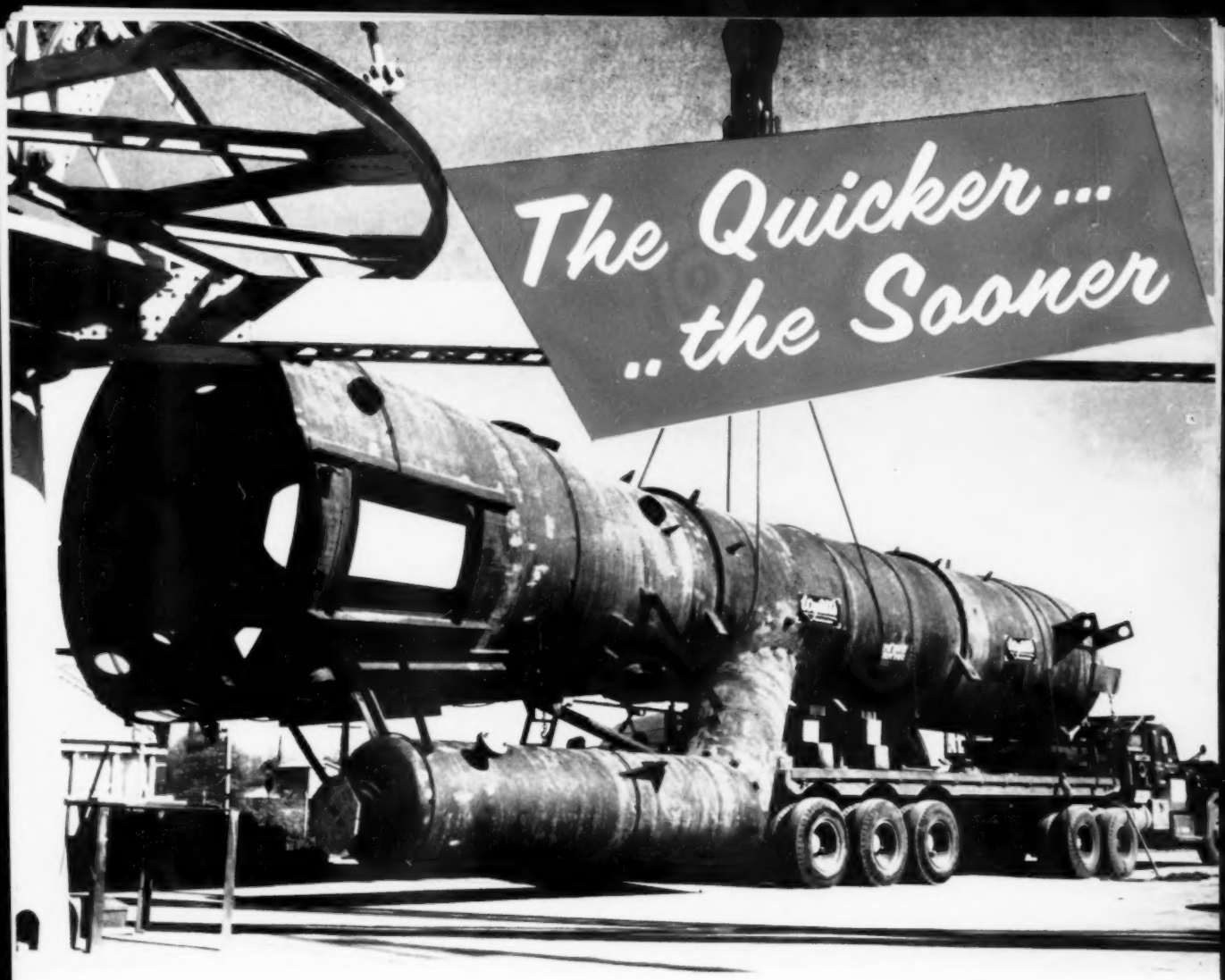

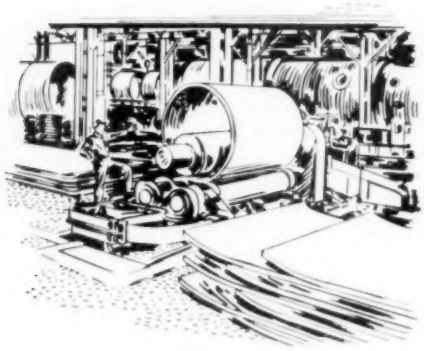

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